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Firepower for Airpower

NOVEMBER-DECEMBER 1957

Bliss chooses TIMKEN® bearings for extra-big loads in world's largest knuckle-joint press

WHEN its customer needed a press to coin cups for artillery shell cases, Bliss created the largest knuckle-joint press ever built—a 4000-ton giant that not only costs less, but actually outproduces a greater-capacity press in this application.

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Full line contact between rollers and races gives Timken bearings their remarkable load-carrying capacity. Made of Timken fine alloy steel, they normally last the life of the machine.

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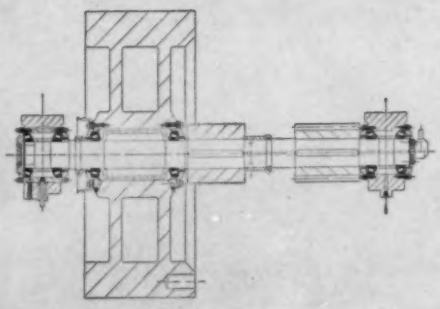
In every machine you build or buy, get all the advantages only Timken bearings can give you—look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



HERE'S HOW E. W. BLISS COMPANY mounts the flywheel of their No. 33 press on Timken bearings, for extra load-carrying capacity and long, trouble-free bearing life.

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ORDNANCE
LAND · SEA · AIR ARMAMENT

The Magazine of Scientific and Industrial Preparedness Now in Its 38th Year

VOL. XLII | NOVEMBER-DECEMBER 1957 | NO. 225

The Cover.—*The 20-mm. Vulcan machine gun was developed by General Electric Company for the Air Force under Army Ordnance contract. Its six rotating Gatling-like barrels can fire at the rate of approximately 7,000 rounds a minute.*

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Advertising Representative: Thomas O. Woolf & Son, Inc., 70 E. Forty-fifth Street, New York 17, N. Y.; 266 South Alexandria Avenue, Los Angeles 4, Calif.

ORDNANCE is published bimonthly by the American Ordnance Association, 708 Mills Building, Washington 6, D. C. Second-class mail privileges authorized at Washington, D. C.

Subscription rate: Continental United States and possessions, $4.50 annually in advance; foreign, $6.00.

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Six weeks' notice before next publication date required for change of address.

FIREPOWER, formerly published separately by the American Ordnance Association, is combined with ORDNANCE magazine.

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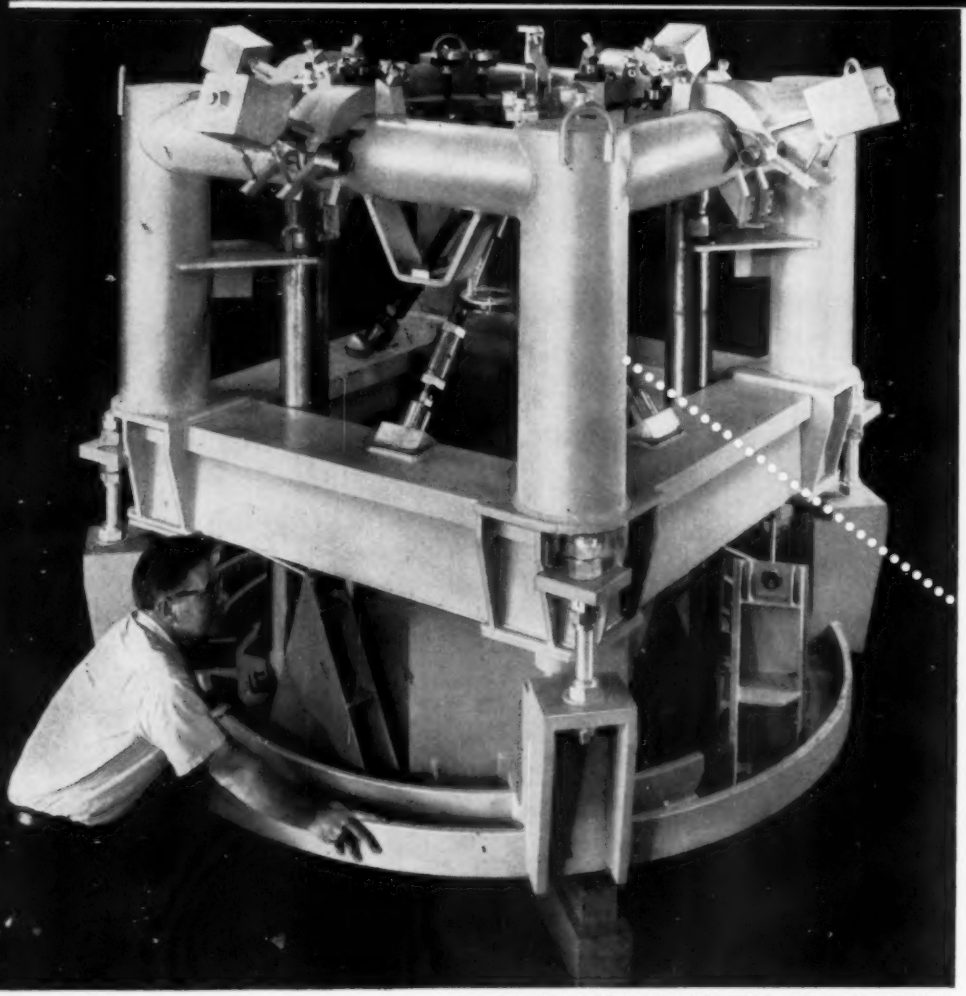
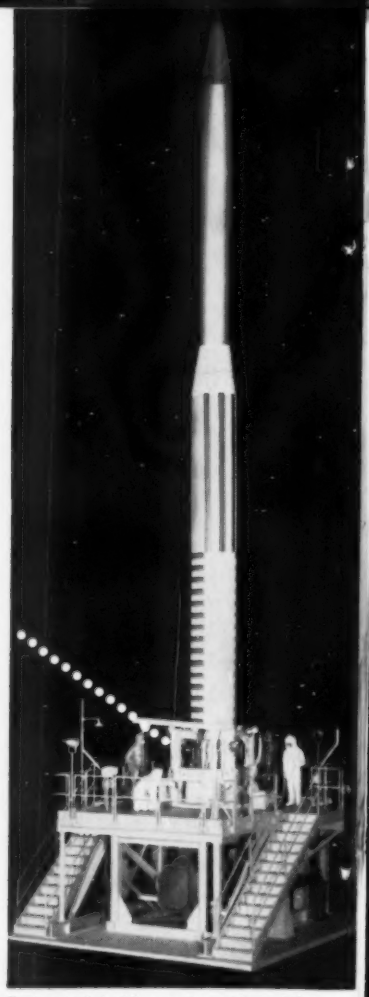


Loewy testing and firing stand for Vanguard launching vehicle.



Scale model of Loewy launching platform and rocket stand and the Martin Company's Vanguard rocket. (On display for the duration of the Geophysical Year at the IBM Vanguard Computing Center, Washington, D.C.)

Loewy plays vital role in 3 major rocket and missiles projects . . .

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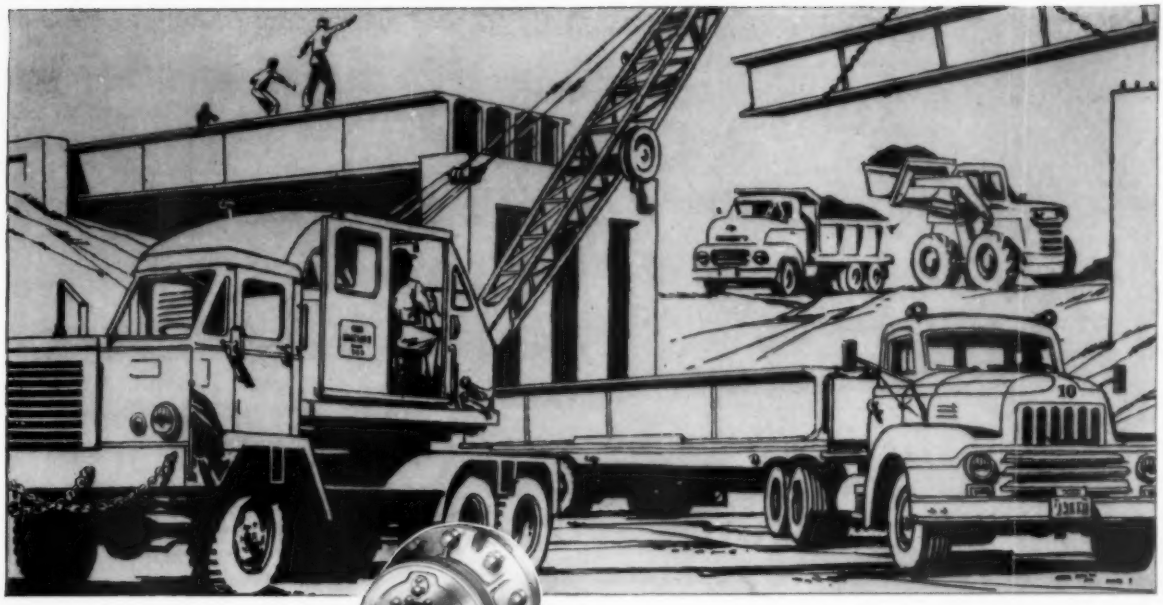

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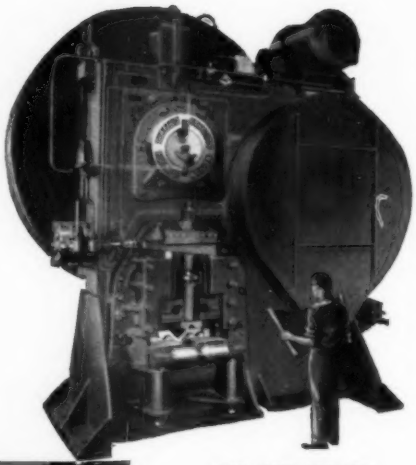

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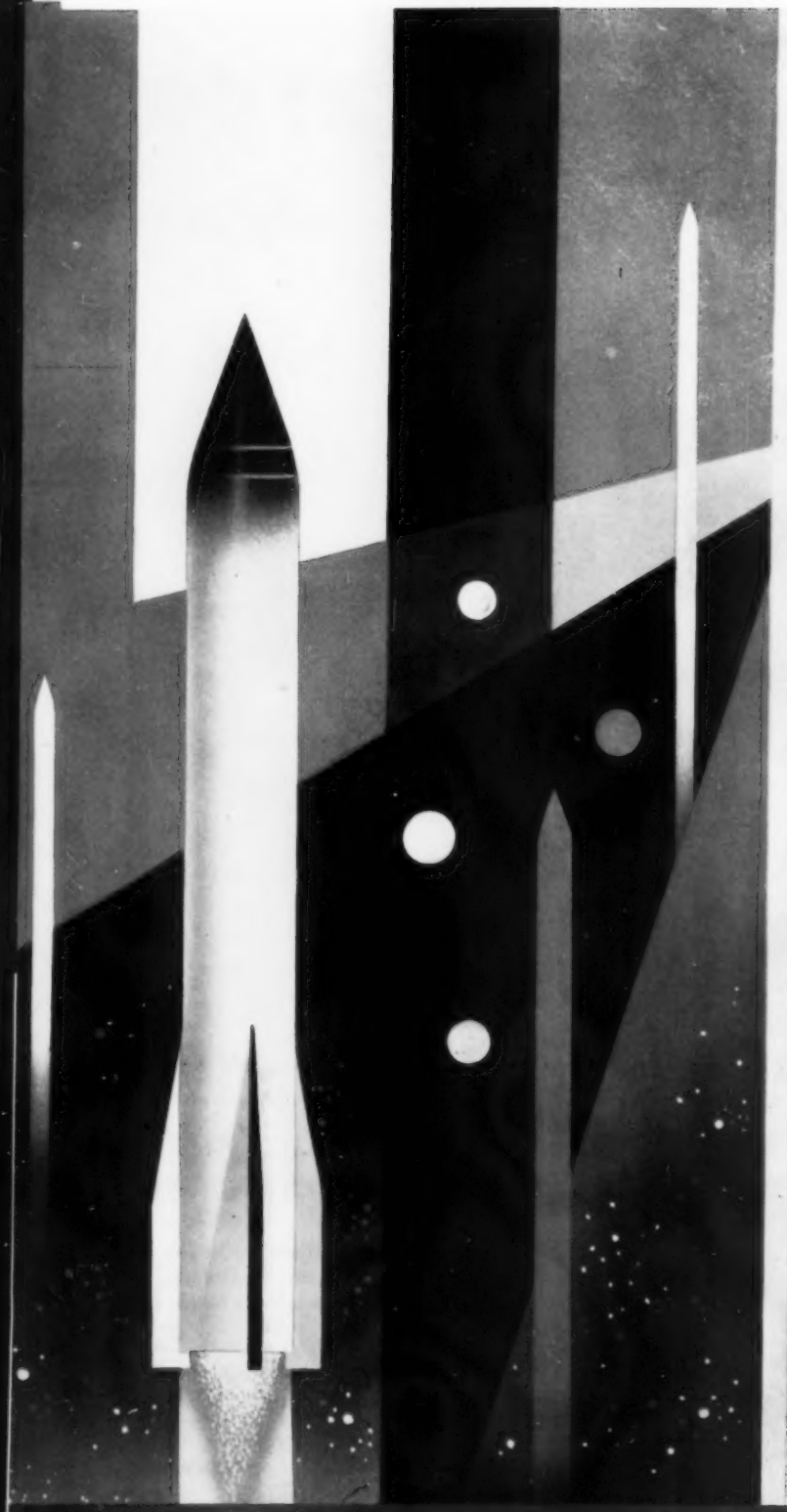

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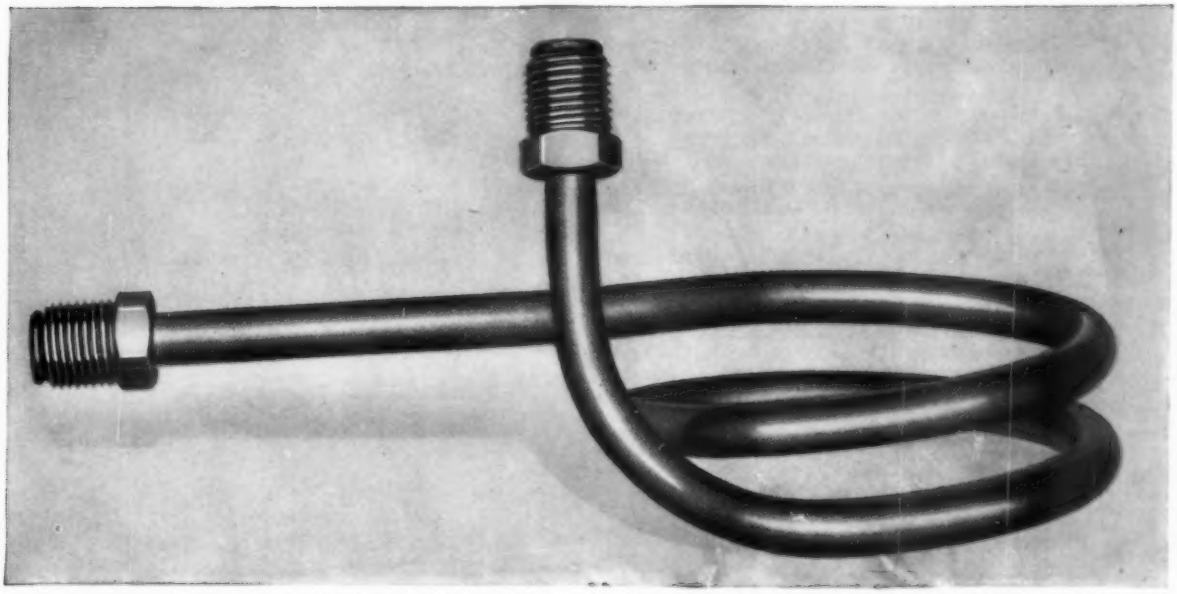
Space limits, low tolerances on brake tube call for Bundyweld's greater ductility



Double loop in this junction tube lets it meet rigid space requirements; also absorbs vibrations set up by differences in the movements of power cylinder and junction block. Tight tolerances are held on both the loop and the position of the ends, which are double-flared with fittings attached.

PROBLEM: Produce a junction tube to fit the restricted space between the power cylinder and junction block in a power-brake system . . . yet hold the low tolerances required for high-speed assembly.

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NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

THERE IS NO REAL SUBSTITUTE FOR

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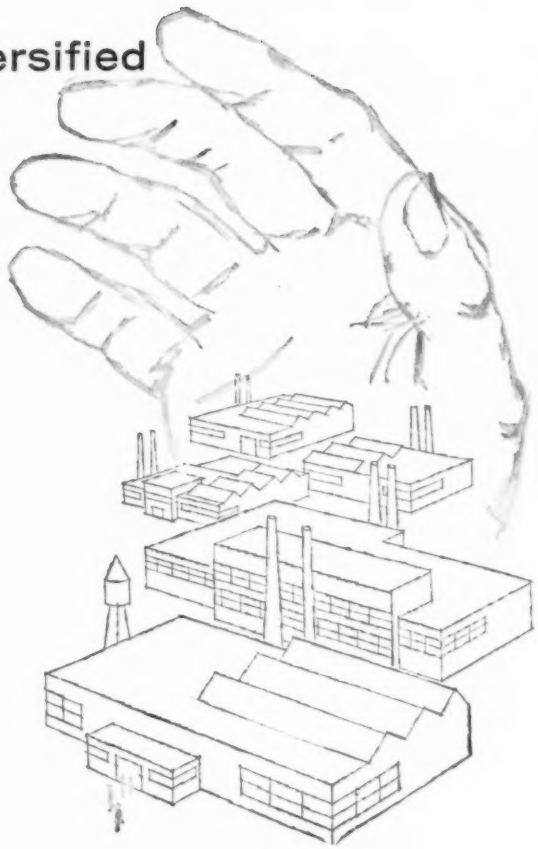
DOUBLE-WALLED FROM A SINGLE STRIP

helping hands . . . united yet diversified



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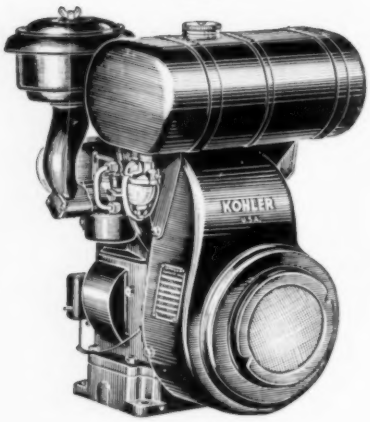
KOHLER ENGINES

K90



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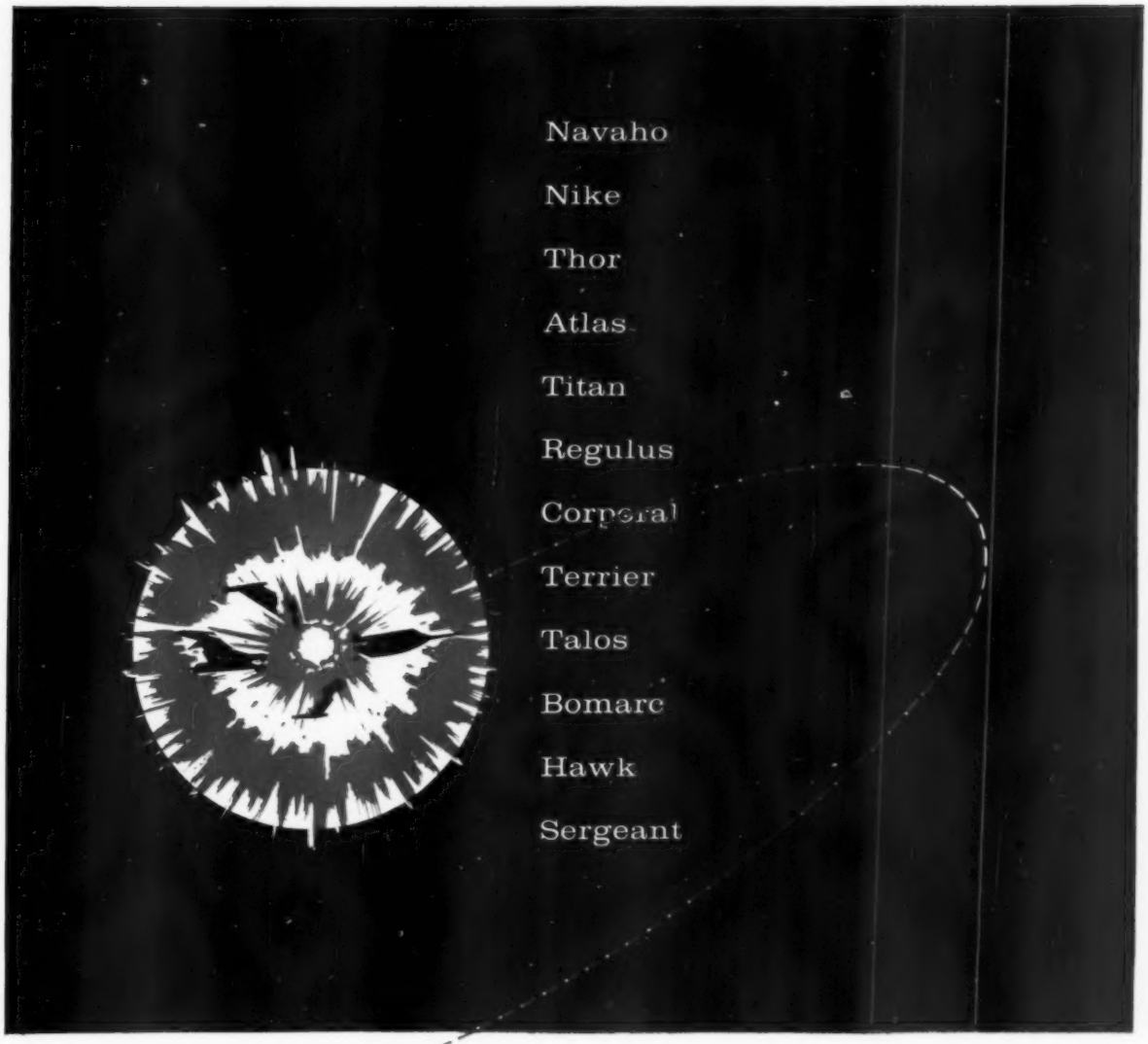

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GRAPHIC • MECHANICAL • ELECTRO-MECHANICAL • ELECTRONIC SYSTEMS

extending the usefulness of man's mind

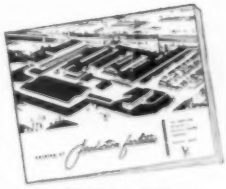
Amweld® Hits Your Cost Target

Forming and flash butt-welding of mill-rolled or extruded shapes has cut the cost of rings and other circular parts by as much as 50%! Savings to one manufacturer in reduced machining time and material was $220.63 per ring. Where expensive metals such as titanium and heat-resistant alloys are used, flash butt-welding offers the most economical and practical method of manufacturing circular products.

Similar economies are also realized on carbon steels and less expensive metals.

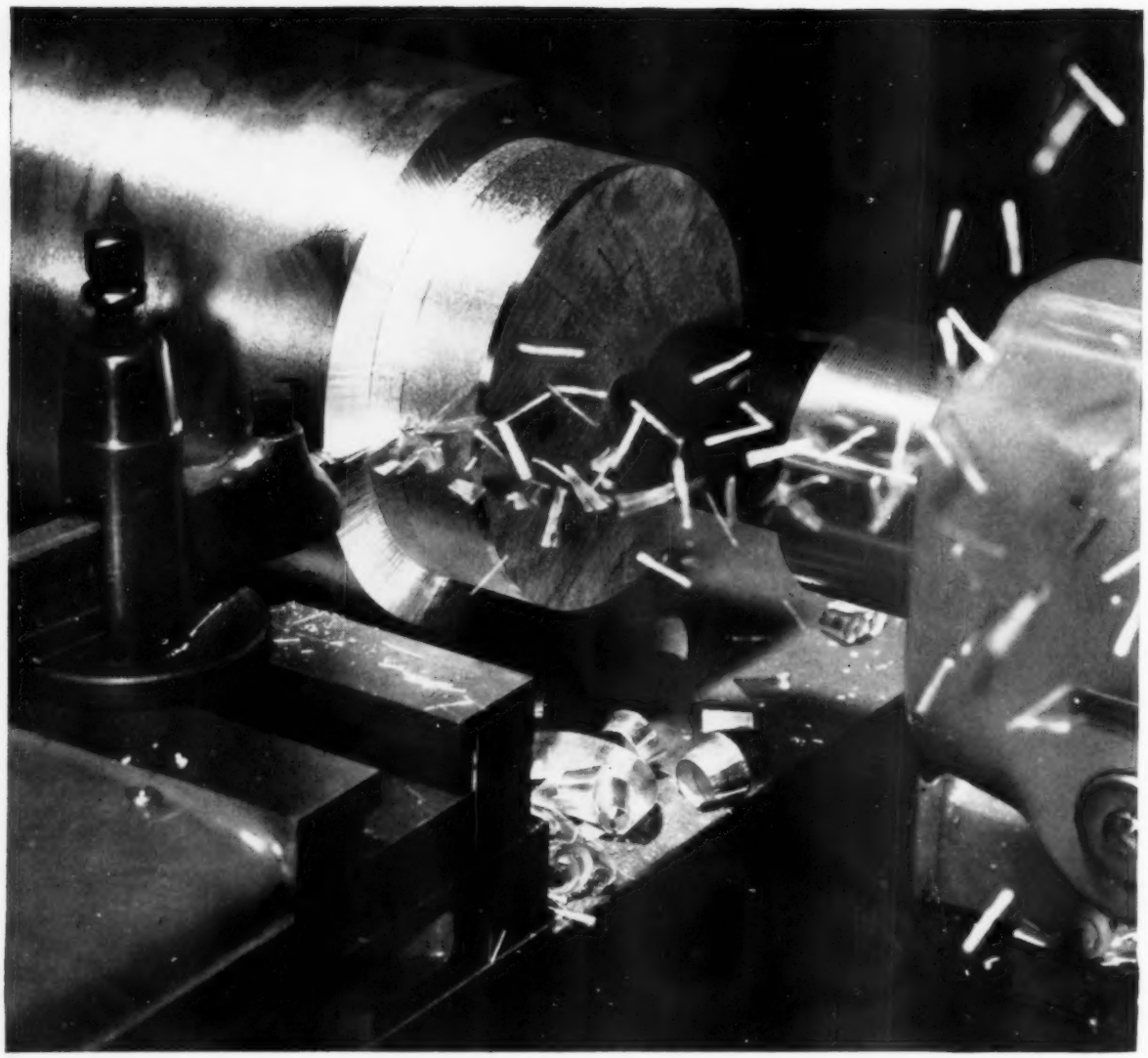
Write today. Let our engineering department demonstrate how Amweld can help you cut production costs on rings, bands and circular components.

THE AMERICAN WELDING & MANUFACTURING CO.
528 Dietz Road • Warren, Ohio



CATALOG
OF PRODUCTION
FACILITIES
Send for your
copy now!

AMERICAN WELDING
The World's Leading Manufacturer of Welded Rings



Speed! Of all structural metals, Magnesium costs less to machine

In the picture above, a lathe is making a roughing cut of 0.800″ in an eight inch magnesium billet. The feed is 0.030 inches per revolution at a speed of 630 feet per minute. In finishing operations, cuts of 0.500″ can be made with a feed of 0.003 ipr and a speed of 5,000 fpm.

That's real speed and efficiency—the kind you can always expect when you machine magnesium. This remarkable metal can be milled, drilled, sawed, reamed, bored, planed, tapped and threaded faster than any other structural metal!

Faster machining means easier machining and lower cost machining. It means more production per hour and per dollar, and longer tool life.

The following table shows how well magnesium compares to the others:

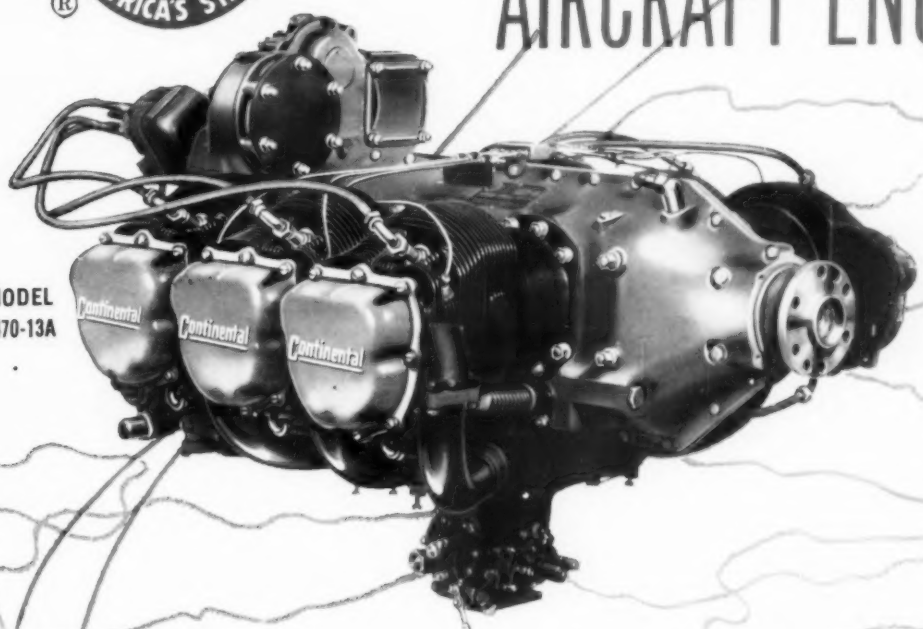
METAL	RELATIVE MACHINABILITY
magnesium	1.0
cast aluminum	1.8
brass	2.3
cast iron	3.5
rolled aluminum	5.0
mild steel	6.5

Let us give you more information about the machinability of magnesium. Contact the nearest Dow sales office or write to THE DOW CHEMICAL COMPANY, Magnesium Department, Midland, Michigan, Dept. MA 1404N.

YOU CAN DEPEND ON DOW

CONTINENTAL MOTORS · Powerful as the Nation · AMERICA'S STANDARD ®

CONTINENTAL AIRCRAFT ENGINES



MODEL O-470-13A

Pilots' First Choice

. . . because they're Continental-engineered for safety, dependability, long-life—and backed by established parts and service facilities the world over.

MODEL	HP	RPM	NO. CYL.	WT. COMPLETE	FUEL OCTANE
A65-8F	65	2300	4	172	80
C90-12F	90	2625	4	186	80
O-300-A & B	145	2700	6	311	80
*O-470-11	190	2600	6	395	80/87
*O-470-15	190	2600	6	400	80/87
E-225	225	2650	6	363	80
*O-470-4	225	2600	6	415	80/87
*O-470-13A	225	2600	6	415	80/87
O-470-K & L	230	2600	6	438	80
O-470-M	240	2600	6	450	91/96
O-470-G	240	2600	6	466	91/96
O-470-H	240	2600	6	510	91/96
FSO-526-A (Helicopter)	270	3000	6	568	91/96
GSO-526-A	320	3000	6	560	91/96

*For military use.

CONTINENTAL ALSO BUILDS THE PACKETTE FAMILY OF FIVE GLOBAL PACKAGED POWER PLANTS, 34 to 220 HORSEPOWER, FOR A WIDE VARIETY OF APPLICATIONS CONNECTED WITH DEFENSE.

Continental Motors Corporation

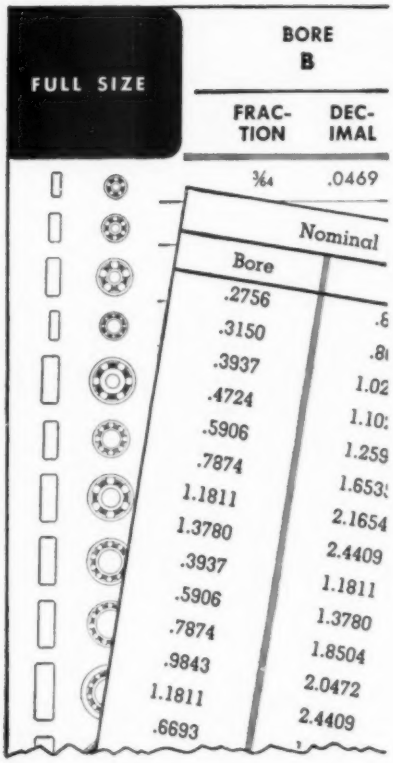
AIRCRAFT ENGINE DIVISION

MUSKEGON • MICHIGAN

ND FACTS

BALL BEARINGS FOR GIANT JETS OR TINY INSTRUMENTS

From high-capacity mainshaft turbine bearings of special steels and finish, stabilized for high temperature operation, down to tiny precision instrument bearings of exquisite accuracy—look to New Departure as the source you can rely on. For New Departure has the experience, the equipment and the ability to produce the world's finest ball bearings.

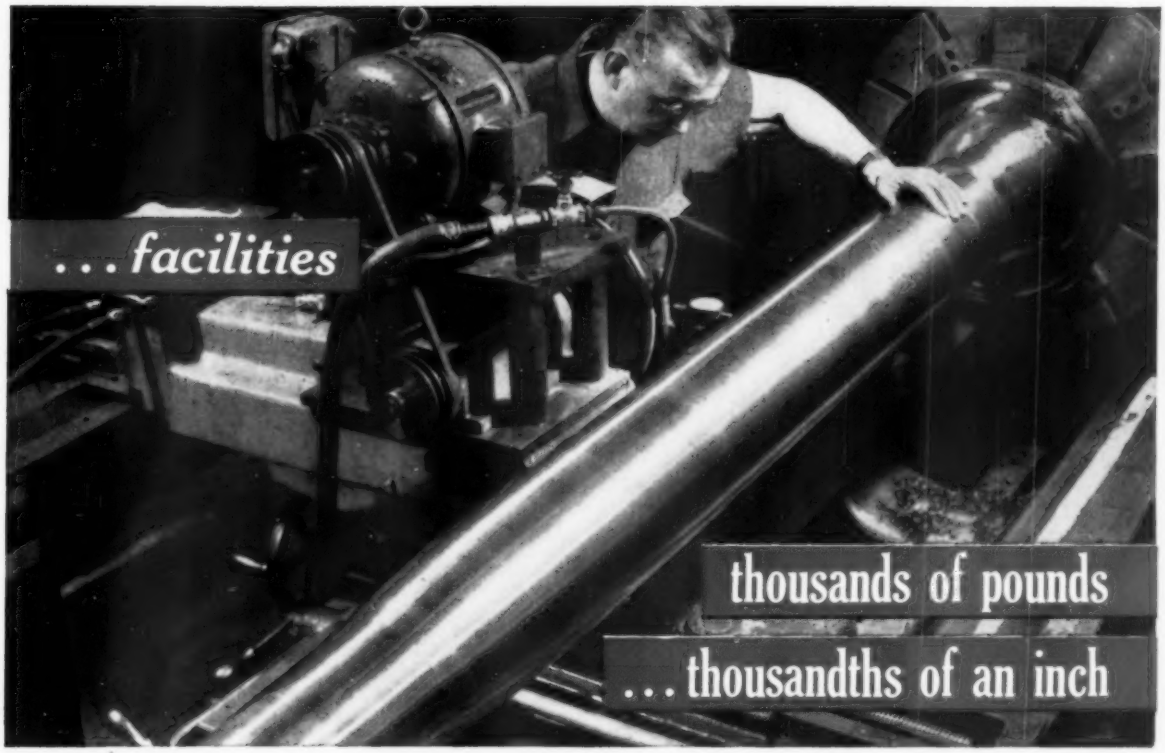


Turbine bearings with two-piece inner rings in bore sizes from 25 to 220 millimeters. Send for New Departure catalog ABC.

Precision instrument bearings in bore sizes from 3/64 to 3/8 inch. Send for catalog PIB.

GM
FORWARD FROM FIFTY

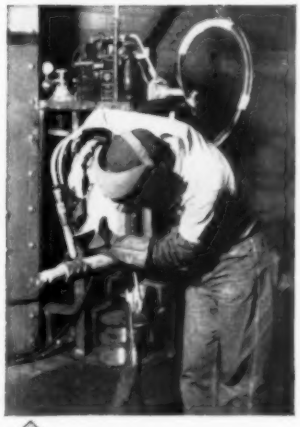
NEW DEPARTURE
DIVISION OF GENERAL MOTORS, BRISTOL, CONN.
NOTHING ROLLS LIKE A BALL



STEAM CATAPULTS FOR NAVY CARRIERS are made at Bliss' Canton plant. Shaft shown here is ground to special taper by mounting grinder on lathe post and guiding it with a specially built duplicating device.

20-mm MACHINE GUNS. Here, barrels are given a salt bath heat treatment in Bliss plant. In addition to production of 20-mm machine guns Bliss manufactures cartridge case and shell making machinery and other ordnance equipment.

140-TON FORGINGS. The 70-foot tie rods for the great hydraulic presses built under the Air Force Heavy Press Program filled little more than half the 120-foot bed of this huge engine lathe. It is one of the more-than-100 lathes in Bliss' 675,000 sq. ft. Canton, Ohio, plant.



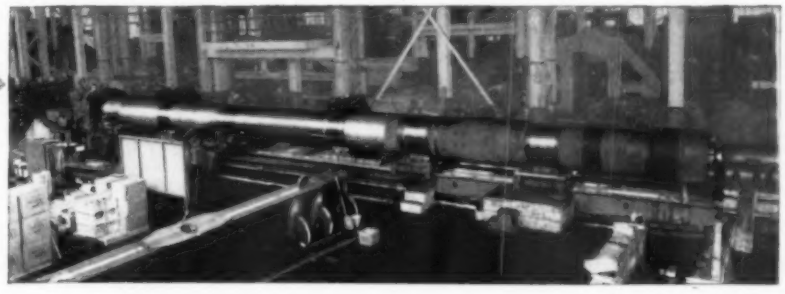
NUCLEAR REACTOR CONTROL RODS produced for the AEC by Bliss. Production requirements involve unusually precise machining and welding practices.

Virtually no contract machining or fabrication job is too large for Bliss facilities. And Bliss' record of long experience and successful performance on past contracts, both civilian and military, is your assurance of precision craftsmanship. In short, before you decide who's going to build it, it's wise to get a bid from Bliss.

BLISS
SINCE 1857

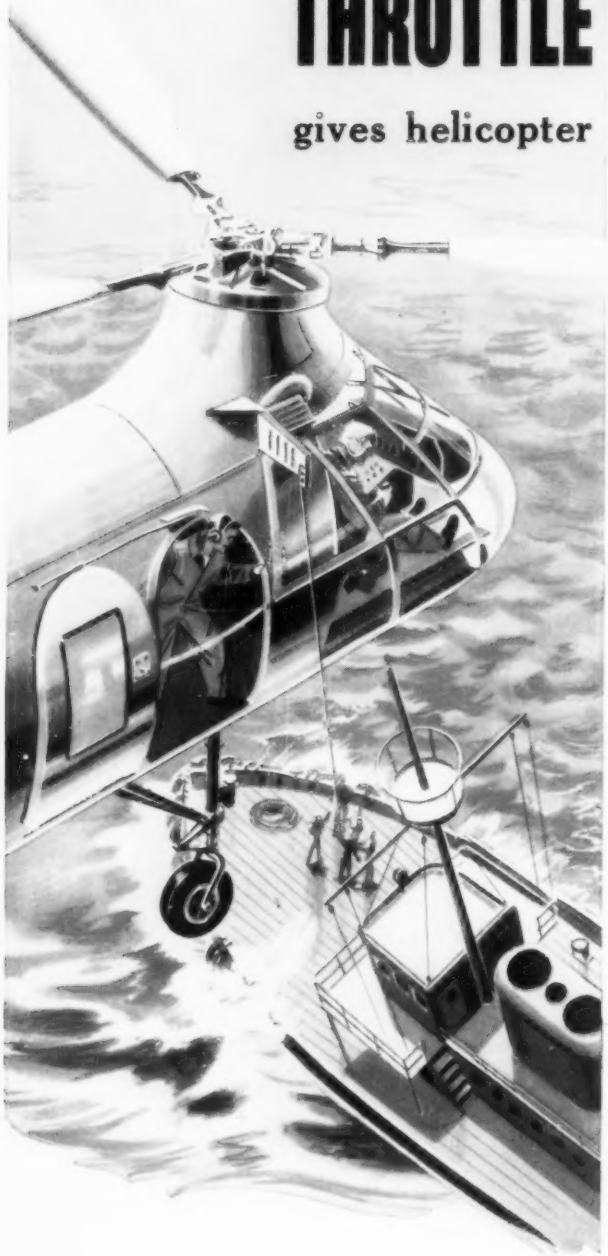
E. W. BLISS COMPANY
General Offices: Canton, Ohio
Presses, Rolling Mills, Special Machinery

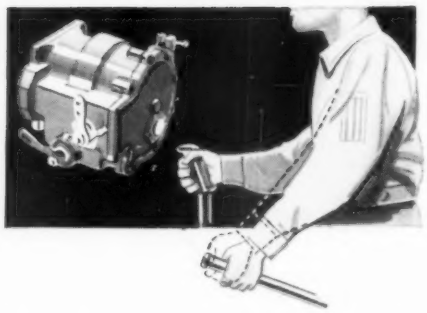
Add these facilities to your own: 11 plants • 2,000,000 sq. ft. • An estimated $44,000,000 inventory of modern tools • Two Meehanite foundries, one iron and one steel foundry • Two fully equipped welding departments.



The CURTISS-WRIGHT Automatic THROTTLE CONTROL

gives helicopter pilots a "Third Hand"





Many times a helicopter pilot wishes he had three hands . . . one to govern direction, another to control the up, down or hover movement, and a third to regulate the throttle. Now, Curtiss-Wright, in cooperation with the U. S. Army and the U. S. Navy, answers this need for a "third hand" with the all-mechanical Automatic Throttle Control.

It makes the pilot's job much easier. He simply sets the desired engine speed with the regular twist-grip throttle . . . the Automatic Throttle Control takes over and keeps engine speed constant, automatically adjusting fuel flow to meet changing conditions.

The Automatic Throttle Control adds immeasurably to the safety and utility of helicopters . . . safeguards engine against overspeed. Planned for use in airships and other throttle-governing applications, it is one more example of the many cooperative contributions by Curtiss-Wright to America's leadership in air transportation.

PROPELLER DIVISION
CURTISS-WRIGHT
CORPORATION • CALDWELL, N. J.

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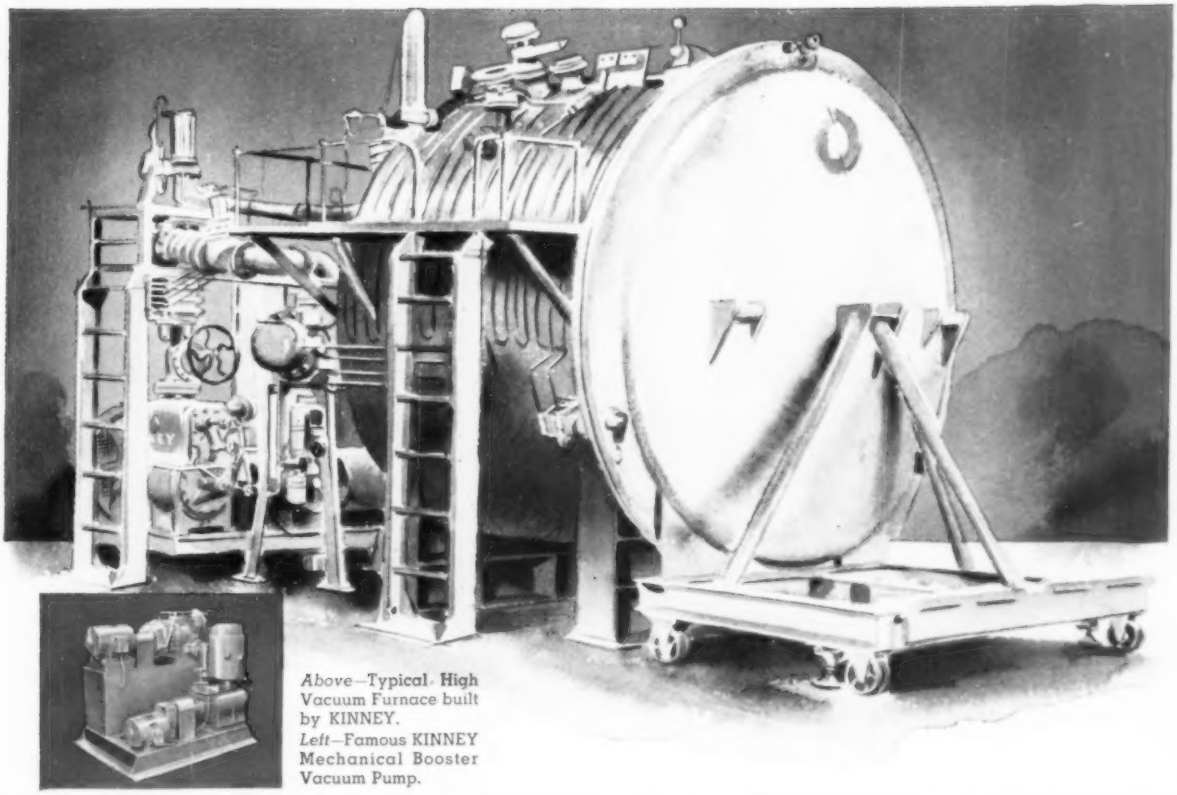


Above—Typical High Vacuum Furnace built by KINNEY.
Left—Famous KINNEY Mechanical Booster Vacuum Pump.

For You—New Opportunities for Product Improvement through VACUUM METALLURGY

KINNEY MFG. DIVISION
Boston, Mass.

High Vacuum Mechanical Pumps, single stage, 13 to 780 cfm, pressures to .01 mm Hg; two stage, 2 to 46 cfm, pressures to .0002 mm Hg; Mechanical Booster Pumps, 30 to 5000 cfm, pressures to .0001 mm Hg. Rotary Liquid Handling Pumps to 3000 gpm.

VACUUM EQUIPMENT DIVISION
Camden, N. J.

Complete KINNEY Vacuum Systems—Vacuum Furnaces (Arc, Induction or Resistance), Evaporators, Optical Coaters and Metallizers, TV Tube Aluminizers; Oil Diffusion Pumps, Gages, Valves and Oils.

WATERTOWN DIVISION
Watertown, N. Y.

Railroad Air Brake equipment of all types; STRATOPOWER Hydraulic Pumps and Motors for Aircraft, to 5000 psi for operation to 400° F.

KALAMAZOO DIVISION
Kalamazoo, Mich.

HYDRECO Hydraulic equipment for industrial and mobile applications. Gear and Dual-Vane Pumps and Motors to 2000 psi, to 120 gpm, to 120 hp. Control Valves to 2000 psi and 150 gpm. Cylinders: Telescopic, Single and Double-acting to 10" diameter, strokes to over 20 ft.

AURORA PUMP DIVISION
Aurora, Ill.

AURORA Centrifugal Pumps to 8500 gpm and 600 ft. heads. APCO Turbine type Pumps, 5 to 150 gpm, heads to 700 ft. Condensate Return Units 800 to 100,000 sq. ft. radiation.

The whole broad picture of metallurgy is undergoing dramatic change with NEW metals, NEW alloys and NEW qualities in conventional metals. Today, engineers and fabricators must "take a second look" because the list of unavailables is being drastically reduced. Many pure metals and alloys, heretofore too costly, are now economically practical. From humble Iron castings to Titanium, Vacuum Degassing is imparting new characteristics, properties and uses to hundreds of metals.

Now, there are KINNEY Vacuum Furnaces for melting, refining and sintering powdered metal parts in volume at temperatures exceeding 2000° Centigrade; furnaces for alloying, consolidating, brazing, annealing, welding and heat treating under High Vacuum or pressurized atmospheres of inert gas.

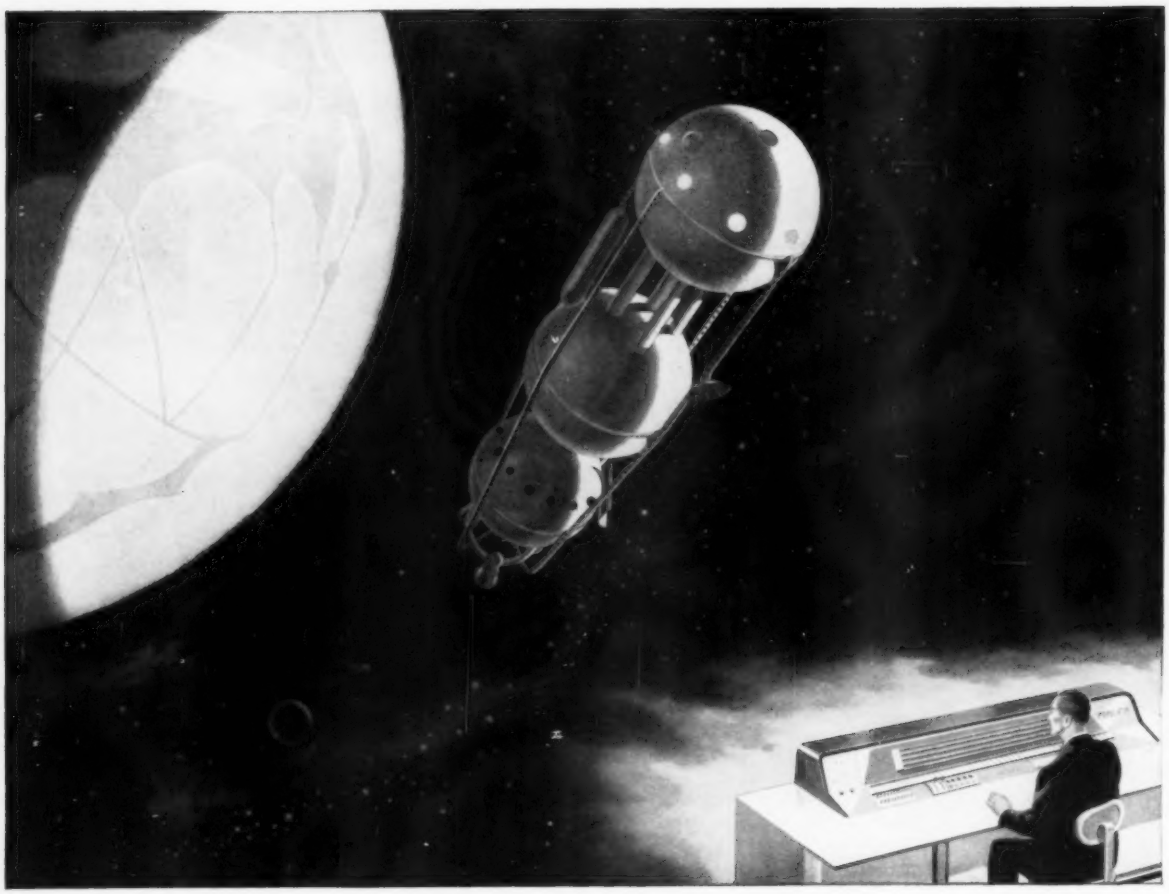
What this means to you is—a broad new horizon of product improvement, reduced rejects, predictable performance – and last, but not least, sound, profitable production.

The KINNEY Mfg. Division of The New York Air Brake Company has, for years, maintained an international reputation for leadership in the development of High Vacuum equipment. Here, High Vacuum "know-how" and Imaginative Engineering spark advanced type High Vacuum Pumps, Components and Completely Engineered Systems for the physicist, research technician and producers of Metals, Electrical and Electronic devices, Refrigeration and Air Conditioning equipment, Optical lenses and many Chemical and Pharmaceutical products.

Write to Kinney Mfg. Division, 3529 Washington St., Boston 30, Mass. for Bulletin No. 1102A and further information on High Vacuum Furnaces.

THE NEW YORK AIR BRAKE COMPANY

230 PARK AVENUE • NEW YORK 17, N. Y.



Large Scale Computers Speed Engineering and Astro-Navigational Data Processing For Coming Interplanetary Travel!

Philco Transac*
S-2000 Computer

Here is the world's first all-transistor, large-scale integrated data processing computer. Years ahead in design and performance, it's another outstanding achievement of Philco research and engineering.

*"TRANSAC"
Trademark of Philco Corporation for Transistor Automatic Computer

Man's conquest of outer space is no longer an impossible dream. Data gained from this year's earth satellite experiments will be used to further man's penetration of the trackless universe.

Toward this end, the U. S. Government, Armed Services, Industry and International Science are joining forces for research and experimentation.

Modern large scale Integrated Data Processing Systems are invaluable in compiling, coordinating and analyzing the huge volumes of significant data being collected. Only through these giant electronic "brains" can the complex calculations involved in the design, engineering, launching and navigation of space ships be accomplished with necessary speed and accuracy.

Tomorrow's interplanetary space ships are but one example of the huge data processing projects which will utilize amazing digital computers to cut engineering manhours to a fraction.

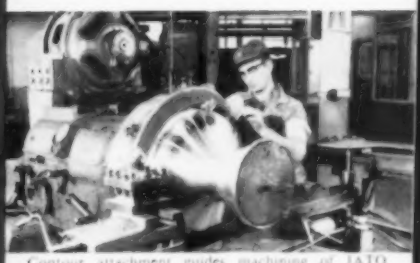
Fulfilling the nation's need for faster, more reliable and compact large-scale data processing systems, Philco is proud to present TRANSAC S-2000.

At Philco, career opportunities are unlimited in computer, electronic and mechanical engineering. Look ahead . . . and you'll choose Philco.

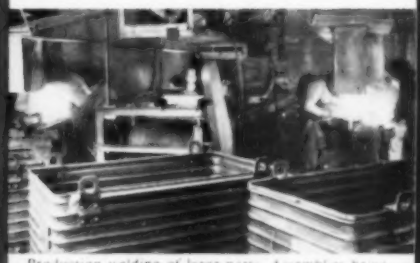
PHILCO® **Government & Industrial Division**
Philadelphia 44, Pennsylvania

This JATO bottle is a glowing red 1600 F. It's on its way into a specially built quench tank, a critical step in heat treating.

X-Ray room is capable of handling small parts and assemblies—or large ones, like 8-foot JATO tube shown here for X-Ray of weld seam.



Contour attachment guides machining of JATO nozzle. Lathe is modified for job with special equipment equally adaptable to work on any large and irregular parts.



Production welding of large parts. Assemblies being fabricated here are delivered to welding tables by conveyor. Parts and components are added in series of sub-assembly production-line welding operations.

experienced missile men at work - - at PARISH

They team production power with precision know-how to meet strict requirements for weapons systems hardware

Here you see the answer to a challenge.

Huge, missile-launching JATOs demand the closest attention to precision. Only the very highest quality metal forming, welding, machining, heat treating and quality control are acceptable. Yet JATOs must be turned out on a mass production schedule. It's a task that requires a unique combination of the most advanced production and precision know-how.

That's why PARISH Pressed Steel is solidly on record as one of the very first successful mass-producers of large precision JATOs.

The same production facilities—the same skill—that answered the JATO's challenge are available now for additional missile systems work. PARISH has the full flexibility needed to handle small or large components, launchers, trailers and supporting equipment in addition to JATOs.

You can count on PARISH to get ready for production fast, work with the closest accuracy and quality controls, and meet the strictest delivery schedules. Get in touch with the PARISH sales staff for specific information—or write for the new PARISH Precision and Production Guide.

● **DANA PRODUCTS : Transmissions • Universal Joints • Propeller Shafts • Axles • Torque Converters • Gear Boxes • Power Take-offs • Power Take-off Joints • Rail Car Drives • Railway Generator Drives • Stampings • Spicer and Auburn Clutches • Parish Frames • Spicer Frames • Forgings**

P PARISH PRESSED STEEL

DANA Division of Dana Corporation / Reading, Penna.

the RIGHT SIZE and SHAPE...

in welded steel tubing

What size do you need? Standard produces welded tubing in a vast range of sizes and grades—stainless, carbon and low alloy. What shape do you need? Standard produces it in round, square, rectangulars, and a host of special shapes. Maybe you have a design problem? The specialists at Standard are anxious to work with you. Whether your requirements call for structural, mechanical, or pressure tubing, Standard produces them to your specifications.

FREE

Write for 8-page folder on all Standard products.

STANDARD

THE STANDARD TUBE COMPANY

24400 PLYMOUTH ROAD • DETROIT 39, MICHIGAN

Welded stainless tubing and pipe • Welded carbon steel mechanical • Boiler and heat exchanger • Exclusive regulized patterns • Special shapes • Steel Tubing—Sizes $\frac{1}{2}$" OD to 5$\frac{1}{2}$" OD—.028 to .260 wall • Stainless Pipe—Schedule 40: $\frac{1}{8}$" to 2" I.P.S.; Schedules 5 and 10: $\frac{1}{8}$" to 4" I.P.S.—Stainless Tube—$\frac{1}{4}$" to 4$\frac{3}{4}$" OD —.025 to .165 wall in square, rectangular, and special shapes of equivalent sizes.

BURROUGHS RADAR DATA PROCESSING EQUIPMENT

INSURES OUR CONTINENTAL AIR DEFENSE

Warning systems for defense in development today are geared to the instantaneous speed of electronic computation.

As a part of this job, Burroughs radar and infrared data processing equipment is fulfilling vital roles in existing military defense systems (one notable example: SAGE). It is assuming key importance in projected air traffic control systems as well.

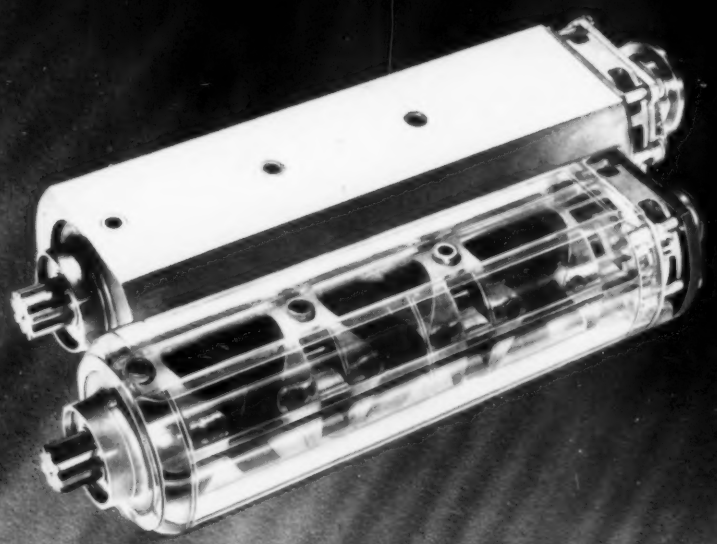
Here is one more demonstration of Burroughs' capability and reliability in all facets of defense projects, from research to field service. Areas of our proved competence include electronic computation and data processing, instrumentation, control systems and communications.

We invite further inquiries. Write, call or wire Burroughs Corporation, Defense Contract Organization, Detroit 32, Michigan. Or Burroughs Defense District Offices: Paoli, Pa. • Dayton, Ohio, 3898 Linden Ave. • Encino, Calif., 17071 Ventura Blvd. • Washington, D.C., 1145 19th St. N.W.

BURROUGHS CORPORATION

THE FOREMOST NAME IN COMPUTATION

Power Actuation at +1000°F



SPECIFICATIONS

Model Numbers	CM-710 *(illustrated)	CM-350	CM-160
Total Length (in.)	13.3	11.8	9.7
Min. Height (in.)	3.1	2.9	2.5
Max. Dia. Envelope (in.)	4.0	3.2	2.5
Weight (lb.)	22	15.5	7.5
Output at 200 psig supply pressure and 1200 rpm (hp)	18.5	9.1	4.2
Starting Torque at 200 psig supply pressure (inch-pounds)	1800	890	400

AiResearch Cam-Piston Air Motors function with complete reliability at extreme temperatures—require no conventional lubrication or cooling

Here are air motors that operate dependably far beyond the temperature limits of electronic and hydraulic units.

Using bleed air as a source of energy, the output of the air motor is almost linear with inlet pressure, allowing maximum efficiency through a wide range of operating conditions. High horsepower and torque to weight ratios are obtained by displacement volume per revolution exceeding the overall volume of the motor.

Motor acceleration is extremely fast — less than .05 second in most applications. Low rotating speeds — from 100 rpm to 2500 rpm — make gear reduction unnecessary and minimize problems of over-speed control, rotational stresses and wear.

Flexibility of the basic design allows for a wide range of motor sizes — from less than 1 hp up to 300 hp — depending on the available pressure supply. Length vs. diameter shape can be changed by varying the number of pistons and/or the piston diameter and stroke.

When coupled with a ball screw which may retract within the full length of the motor shaft, the cam-piston air motor has wide application as a compact, high-performance linear actuator in high temperature pneumatic power control systems.

Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California ... Phoenix, Arizona

Designers and manufacturers of aircraft and missile systems and components: REFRIGERATION SYSTEMS • PNEUMATIC VALVES AND CONTROLS • TEMPERATURE CONTROLS CABIN AIR COMPRESSORS • TURBINE MOTORS • GAS TURBINE ENGINES • CABIN PRESSURE CONTROLS • HEAT TRANSFER EQUIPMENT • ELECTRO-MECHANICAL EQUIPMENT • ELECTRONIC COMPUTERS AND CONTROLS

The PUSH behind the Sidewinder's Sting!

...A development of Hunter Douglas

Effective at altitudes up to 50,000 feet, the Navy's air-to-air guided missile, SIDEWINDER, is a rugged, sensitive and reliable weapon. Encompassed in its incredibly small 5" diameter and 9'5" length are all necessary propulsion and guiding equipment plus a deadly warhead. Surprisingly, the SIDEWINDER is unusually economical; produced at a cost comparable to a load of aircraft cannon bullets... *an economy resulting directly from Hunter Douglas technical achievements in the field of cold forging!*

The major problems of producing a light, strong motor tube meeting precision tolerances required in this type of propulsion unit were jointly solved by a closely cooperating team. The Naval Ordnance Test Station at China Lake, California, was responsible for design, with Hunter Douglas engineers concentrating on means of mass production. The SIDEWINDER motor tube was produced as a single precision aluminum cold forging integrating the tube and wing supporting channel ring section, eliminating costly assembly operations and alignment difficulties. The tube is typically straight within .020" TIR, I.D. within .006", wall thickness within .0015" and yield strength of 72,000 psi minimum.

Completion of Hunter Douglas experimental cold forging techniques helped pave the way for mass production of the SIDEWINDER. Today, Hunter Douglas is the only successful producer of this complex cold forged component and is the prime contractor to the U.S. Navy, delivering the completely assembled SIDEWINDER motor, ready for final addition of propellant, warhead and guidance unit.

Behind this notable Hunter Douglas achievement stands a strong integrated business structure combining technical resources, manufacturing facilities and the coördinated staff to see all jobs "WELL DONE."

Hunter Douglas Aluminum

Division of

BRIDGEPORT BRASS COMPANY

Dept. O-11, Riverside, California, Telephone OVerland 3-3030

CLEVELAND CONTAINERS CAN TAKE IT!

DESIGNED FOR INTERPLANT AND FINAL SHIPMENT OF GUN BARRELS.

Pictured are two gun barrel containers . . . one used in interplant shipments during the manufacture of the barrel . . . the other for final shipment to the Government.

The top container has made 25 such trips between plants located some distance apart, and still is in serviceable condition. Strong enough to protect gun barrels in interplant shipments for separate manufacturing operations . . . they are tough enough to be used over and over!

The second container, designed for final shipment is made to military specifications. Prior to packaging, gun barrel is wrapped in anti-corrosive paper which, together with the construction of the container, preserves the barrel. Can easily be opened for inspection . . . and resealed.

End pads are provided to cushion all such heavy items.

THE ADVANTAGES ARE MANY:

- Eliminate damage to contents in interplant and final shipment.
- Convenient to store.
- LOW packaging cost per unit . . .
  LOW handling cost . . .
  LOW transportation charges.

Write us for help in working out similar packaging problems.

☆ ☆ ☆

Why pay more? For quality products . . . call CLEVELAND!

THE **CLEVELAND CONTAINER COMPANY** •

6201 BARBERTON AVE., CLEVELAND 2, OHIO

PLANTS AND SALES OFFICES: CLEVELAND, DETROIT, CHICAGO, MEMPHIS, LOS ANGELES, PLYMOUTH, WIS., JAMESBURG, N. J., OGDENSBURG, N.Y. • ABRASIVE DIVISION CLEVELAND

SALES OFFICES: NEW YORK CITY, WASHINGTON, D. C., ROCHESTER, N. Y., WEST HARTFORD, CONN.

• ALL-FIBRE CANS • COMBINATION METAL AND PAPER CANS • SPIRALLY WOUND TUBES AND CORES FOR ALL PURPOSES

CLEVELAND CONTAINER CANADA, LTD.
Plants & Sales Offices: TORONTO AND PRESCOTT, ONT. Sales Office: MONTREAL

ATOMIC ENERGY

NUCLEAR STANDARDS

The first steps toward world standardization for the peaceful use of nuclear energy were taken recently by sixty-one delegates from thirteen countries at a meeting of the International Organization for Standardization (ISO), Geneva, Switzerland.

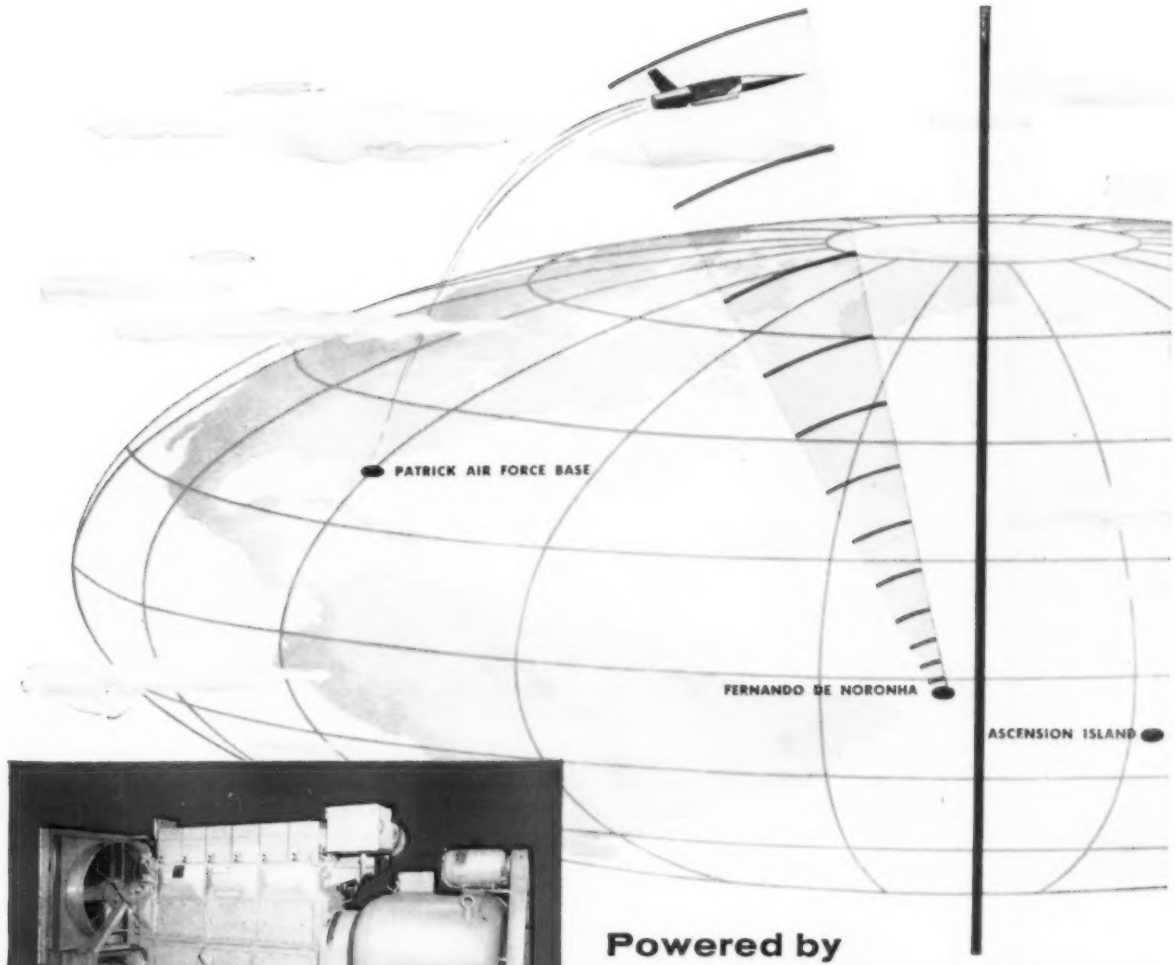
Under the chairmanship of Morehead Patterson, president, American Machine & Foundry Company, New York, N. Y., the first meeting of ISO Technical Committee 85 on Nuclear Energy outlined six areas of work. They are:

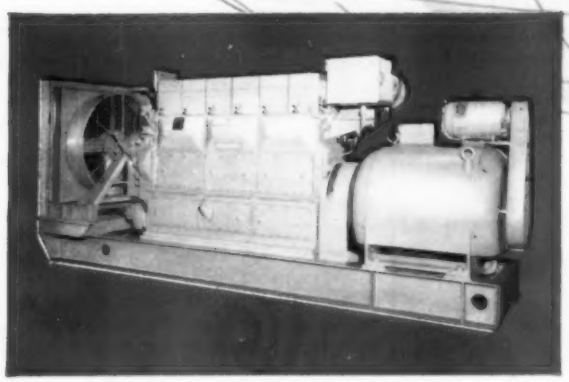
1. Development of a trilingual glossary of terms applicable to nuclear energy and based on work already done in various countries.
2. Development and approval of a warning symbol for use wherever danger from ionizing radiation is present.
3. Adoption of units pertaining to nuclear energy development by the International Commission on Radiation Protection and the International Commission on Radiological Units.
4. Development of symbols required for drawings pertaining to nuclear equipment and installations.
5. Development of international recommendations relating to measurement of radiation and protection against radiation.
6. Development of internationally acceptable guides for safe design, operation, and maintenance of nuclear reactors.

NEW SHIP REACTOR

The Atomic Energy Commission and the Maritime Administration have extended an invitation to industry for proposals to develop a nuclear power plant, suitable for propelling merchant ships, consisting of a gas-cooled reactor coupled with a closed-cycle gas turbine.

This action is a continuation of a joint long-range program aimed at the development of advanced reactor systems for commercially competitive propulsive power of ships in the U. S. Merchant Marine. As part of this development program, studies of the feasibility of nuclear propulsion of gas-cooled, closed-cycle systems have been completed by the General Motors Corporation; Ford Instrument Company, a division of Sperry Rand Corporation; and General Atomic, a division of General Dynamics Corporation. It has been





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Portions of other strategic U.S. defense systems, like the "Texas Towers" (Early Warning Radar Stations), the "DEW" line (Distant Early Warning), and the "SAGE" project (Semi-Automatic Ground Environment), will also rely on Superior engines—proof again of their rugged dependability. If your requirements range from 215 to 2150 horsepower, or 150 to 1500 KW, benefit from White's many advanced Superior design features! *Get complete information now!*

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Atomic Energy (Contd.)

concluded from these studies that further work should be undertaken to verify the high promise of this system.

The long-range development program is in addition to the work now progressing on development and construction of the first nuclear-powered merchant ship announced by the President on October 15, 1956. The Babcock & Wilcox Company is carrying forward work under a $9,872,000 contract to supply major components of the pressurized-water nuclear propulsion plant for this ship. A preliminary design of the vessel itself has been completed, and it is anticipated that a contract for its construction will be awarded in the next few months. The ship is scheduled for operation in 1960.

INDEMNITY LEGISLATION

The Atomic Energy Commission has issued a temporary regulation designed to give immediate protection to the public and to licensees and their suppliers against losses arising from reactor accidents. The regulation is based on Public Law 85-256, the indemnity legislation signed by the President September 2, 1957.

The new legislation on which the temporary rule is based amends the Atomic Energy Act of 1954 to provide that reactor licensees shall have financial protection in amounts prescribed by the Commission. The Commission will then indemnify each licensee and his suppliers, up to $500 million for each reactor accident, against claims arising from nuclear accidents which exceed the amount of financial protection required to be possessed by the licensee.

A principal purpose of the temporary regulation is to specify the amounts of protection that present holders of reactor licenses shall maintain. The amounts prescribed are based on the thermal energy capacity of the licensed reactor, at the rate of $150,000 per thousand kilowatts of thermal energy, but in no event may a licensee have less than $250,000 of financial protection.

REGULATION AMENDED

The Atomic Energy Commission has amended its Access Permit Regulation to broaden the criteria for access by private individuals or organizations to secret restricted data on controlled thermonuclear processes.

Information on controlled thermonuclear (fusion) processes is designated in the Access Permit Regulation as "Category 20." As amended effective August 15, 1957, the regulation provides that in addition to establishing a "need to know" in the applicant's business, trade, or profession—the normal requirement for access to secret data—the applicant for access to Category 20 must also demonstrate that he: *(Continued on p. 424)*

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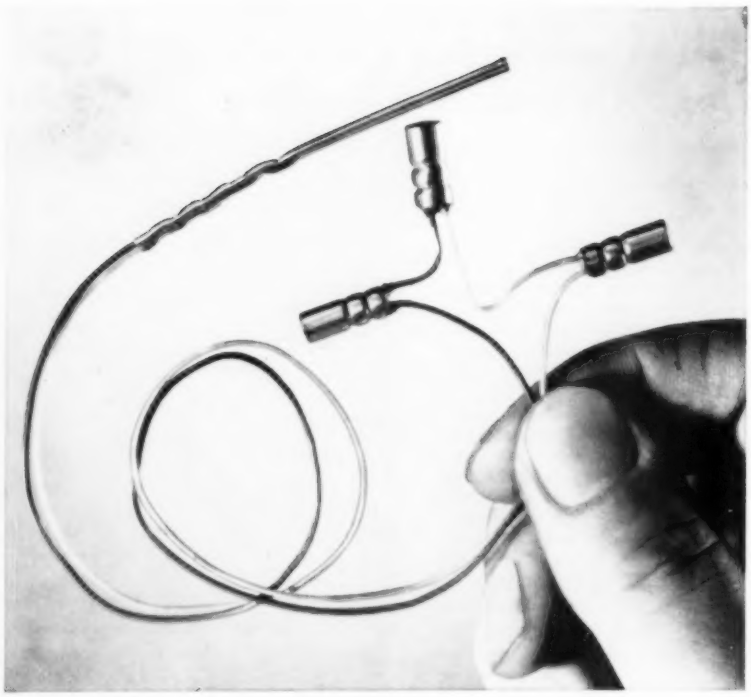

Batteries in "suspended animation" brought to life in one second by Du Pont S-81 Squibs

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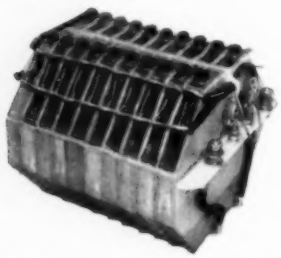

The electrolyte and plates are held in separate chambers until the battery is needed. The instantaneous squibs are then fired, and within one second the battery delivers full power to the driving motor.

Exide states that only the extreme reliability and uniformity of the Du Pont Squib make this application possible. Batteries can now be held "at the ready" as long as necessary and put into use at a moment's notice.

This application illustrates one of the unusual problems being solved by Du Pont Explosive Specialties such as electric detonators; high temperature aircraft blind expansion rivets; MS delay connectors and a wide variety of squibs.

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Atomic Energy (Contd.)

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A-AID FOR BRAZIL

The Governments of the United States and Brazil recently signed an agreement on the civil uses of atomic energy which authorizes United States assistance to Brazil in developing a nuclear power program.

This agreement provides that the United States will make available as needed, for a term of 20 years, 550 kilograms of uranium 235 to be contained in fuel leased or sold to Brazil for its reactors.

The National Nuclear Energy Commission for Brazil will supervise arrangements for the fueling of the 11,500-kilowatt nuclear plant which will be erected at a site as yet undetermined.

The agreement will enlarge the areas of cooperation between the United States and Brazil in the peaceful applications of nuclear energy. It will authorize, for example, the sale of gram quantities of special materials for laboratory use and, in the event that Brazil decides to build a material-testing reactor, the designation of six kilograms of reactor fuel at a ninety per cent enrichment in U 235.

Upward of 500 shipments of radioisotopes have been sent to Brazil. Brazilian scientists and technicians have taken special training courses at the International School for Nuclear Science and Engineering at the Argonne National Laboratory and the Oak Ridge Institute of Nuclear Studies at Oak Ridge, Tenn., and also at the Phoenix atomic project at the University of Michigan.

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HON. NEIL H. McELROY

The Secretary of Defense

For a Balanced Defense

The New U. S. Secretary of Defense has a serious task ahead of him

THE appointment of Neil H. McElroy as Secretary of Defense will assure to the vast establishment he directs a freshness of viewpoint and executive direction with which his successful industrial record has been marked. The members of the Ordnance Association greet him with especial felicitation, for as a long-time member of the A.O.A. they have come to know him and his company as symbols of patriotic leadership.

Similarly, the departure of Secretary Wilson from the Defense Department marks the termination of service of a colorful leader who also has been a member of the Ordnance cohorts over a lengthy period. He was the recipient of gold medals of the Association on two occasions—the Crozier Gold Medal at New York when in 1953 he addressed the society on the responsibilities of industry to our national defense and the Harrison Gold Medal at Cincinnati in 1951 when he announced his plan of stand-by armament production in a memorable address which was published in this journal.

THERE are elements of similarities between the new Secretary and his predecessor which, while in no way meant as comparisons, afford a reasonable basis of appraisal. Both are industrial leaders of proven caliber who have conducted worldwide operations of companies whose products span the earth. Both accepted the call to public service at great personal financial sacrifice. The organizations which both directed—General Motors in the case of Secretary Wilson and Procter & Gamble in the case of Secretary McElroy—were and are essential factors in the military and industrial preparedness of the United States.

Neil H. McElroy, newly appointed Secretary of Defense, is no newcomer to defense problems. As president of Procter & Gamble Company he directed the activities of a large diversified organization which has contributed in peace and war to quantity production of American armament. In addition, he has devoted much of his time and energy to local and national civic activities. In 1955 he was chairman of the White House Conference on Education.

A native Ohioan, Secretary McElroy was born in Berea in 1904. He was graduated from Harvard in 1925 and immediately therafter joined Procter & Gamble where he held positions of promotion and advertising manager. In 1943 he was made a director of the company and vice-president in charge of advertising.

In addition to his responsibilities as Procter & Gamble's chief operating executive, Mr. McElroy, prior to his acceptance of the Secretaryship, was a director of the General Electric Company and the Chrysler Corporation.

He is a former chairman of the National Industrial Conference Board, a former president of the Association of Soap and Glycerine Producers and of the Associated Harvard Clubs, and a former member of the board of overseers of Harvard University. He also has been identified with many civic, cultural, and charitable organizations of Cincinnati. He has been a member of the American Ordnance Association for many years.

While the uninitiated would readily concede to General Motors a vital place in the national-defense structure, the place of Procter & Gamble is not as commonly known. Yet it is a fact that the Nation's No. 1 soap maker was also during World War II and during the Korean war one of the largest producers of artillery ammunition. Not only was the record preëminent in quantity but in quality and low cost as well. It is safe to say that no two public servants have responded more generously to the call of duty after serving as heads of two of the country's largest successful industrial enterprises.

BUT there is an added flavor in Secretary McElroy's competence. His industrial experience has been more in the promotion and sales fields than in production techniques. And in this there is cause for jubilation. At the moment the Department of Defense definitely needs promotion. The budget ax has weakened the very fiber of the entire system—Army, Navy, Air Force, and Marines. What was a team of high morale and superb achievement suddenly has the budget jitters. Defense is being made to bear the brunt of the economy wave at a time when rising international obligations and more brittle tensions seem to have increased rather than lessened. And this in the face of strange spending policies of the Federal Government for many nonessential projects.

The Communist nations of the world are increasing their manpower and are building up fleets of submarines and surface ships. Their aircraft have shown a high order of design and manufacturing skill, and their development of guided missiles and nuclear weapons goes on apace. In the face of this continuing increase of power among such nations it is difficult to see how our defense forces can be cut any further without endangering our country's security.

Indeed, the national-defense times are out of joint, and Secretary McElroy has his job cut out for him. None will wish him well more ardently and offer their support more willingly than his more than 42,000 fellow members of the American Ordnance Association.

Limited War, 1957

To avoid being "nibbled to death" the Western nations should provide forces capable of discouraging or winning limited wars while maintaining long-range ability to deter all-out conflict

Hoffman Nickerson

TODAY there is an increasing discussion of an idea seldom mentioned before 1945—limited war. Even before the Communists broke the U. S. atomic monopoly they had developed a strategy of limited aggression which by-passed the fearful power of the new bombs.

When the Soviets began to possess both atomic and hydrogen explosives, then an "all-out" war, including the long-range bombing of cities, began to seem not worth while. Obviously there is no point in beginning a conflict in which the damage to both sides would probably be so great that there could be no victor.

On the other hand, the Communist strategy of limited war has had some success. By holding a considerable part of North Korea the Red Chinese have notably increased their prestige in Asia. By conquering an appreciable part of Indochina, world Communism has created a new satellite state.

THUS, in Vice-President Nixon's striking phrase, perhaps the West might be "nibbled to death" without being able to do anything about it except by unleashing mutual destruction. Accordingly, we and our allies should not only go on discouraging the Soviets from beginning an all-out nuclear war; we should also prepare to discourage the outbreak of limited wars or, if we fail in that, to win such wars.

Limited wars between great powers are those in which both sides are content to "score points" against each other instead of both trying for a knockout. In other words, after achieving a measure of success the partially victorious side is willing to offer terms of peace so moderate that it is to the interest of the partially defeated side to accept them rather than accept the sacrifices and risks of further fighting. Consequently such conflicts do not create as severe a social strain as wars of unconditional surrender.

Limited war has long been a subject of special research for Mr. Nickerson. Among his many books of historical research, "Can We Limit War" was the title of a volume published in 1934, and "The Armed Horde, 1773-1939" appeared in 1940. Mr. Nickerson is a frequent contributor to ORDNANCE, *his most recent article, "War and History," having appeared in the November-December 1956 issue.*

All-out and limited wars have alternated throughout history, and usually the change from one form to the other has had nothing to do with changes in weapons and military instruments.

The past periods of unlimited war in the West have been ended by a general realization through bitter experience that—in Maj. Gen. J. F. C. Fuller's words—unlimited war is as foolish and immoral as unlimited eating and drinking. The part played by the bombardment airplane in fostering recent all-out wars because it provides a new means of attacking civilians is historically exceptional.

RECENT Western discussion of limited war includes three books: "Atomic Weapons and East-West Relations" by P. M. S. Blackett, an English professor of physics experienced in military electronics; "Nuclear Weapons and Foreign Policy" by Henry A. Kissinger; and "Limited War, the Challenge to American Strategy" by Prof. Robert E. Osgood of Chicago University. There is also a pamphlet "On Limiting Atomic War" by Professor Blackett, Rear Adm. Sir Anthony Buzzard of the British Navy, and others, published by the British Royal Institute of International Affairs; and an article by James E. King, Jr., "Deterrence and Limited War," in the August issue of *Army* magazine.

These writers, with their very different backgrounds of experience and scholarship, have much in common. All emphasize that every limitation of war—as to area, weapons, targets, and in general the proportion of national resources to be committed—must be mutually acceptable or else the war would not remain limited. Also this mutual acceptability must be based solely on mutual unwillingness to begin all-out nuclear war.

The restrictions should be clear, simple, and fully understood by being publicized beforehand. The mutual agreement to observe them would be tacit, and would depend more upon actions than words. Both sides, while willing to overlook an occasional not-too-important violation as accidental, would be free to act unrestrictedly if the enemy began to adopt an unrestricted policy.

King differs from the others by holding that since the use or nonuse of nuclear weapons in any form is the clearest of all suggested restrictions, the West should explicitly renounce being the first to use them except in case of a large-scale Communist attack westward in Europe and perhaps an attack on the Near Eastern oil supplies on which so much of West European economic activity depends.

All the other writers favor the admittedly more complicated procedure of using tactical atomic weapons against aggressive Communist armed forces, arguing that such conflicts can be limited and that the comparatively plentiful Western supply of small atomic bombs would handicap the Communists for some time to come.

BLACKETT and Buzzard emphasize that deterrence should be graduated; *i.e.*, that instead of proposing wholesale nuclear destruction in case of minor Communist aggressions the punishment should fit the crime. They admit that the specific restrictions which they suggest are tentative, but they hold that those restrictions would stand a better chance of being observed in the excitement of wartime if they had been publicly discussed beforehand.

They harshly criticize a number of official American and especially British defense-policy statements on the ground that those statements exaggerate the willingness of Western governments to engage in retaliatory nuclear city bombing in many specific cases.

This so misleads public opinion as to what the governments probably would do that in a crisis national unity might be damaged.

Blackett also makes another point which, although strictly logical, seems too much of a counsel of perfection to be acted upon. Since the Soviet power to wage all-out nuclear war, although less than that of the West, nevertheless goes far toward inhibiting the use of Western city-bombing nuclear power, he reasons that England and the U. S. should not try to keep ahead of the Soviet in this respect but should be content to keep up a reasonable but inferior long-range nuclear power and should put most of their available defense budgets into preparing for limited war as the more probable form of Communist armed aggression. One can hardly imagine any Western government deliberately doing so.

"Limited wars between great powers are those in which both sides are content to 'score points' against each other instead of both trying for a knockout. In other words, after achieving a measure of success the partially victorious side is willing to offer terms of peace so moderate that it is to the interest of the partially defeated side to accept them rather than accept the sacrifices and risks of further fighting."

Osgood's book is detailed, scholarly, and systematic. Rightly assuming that the whole idea of limited war will be unfamiliar to many readers, he begins by an analysis of it, noting that it will be both unfamiliar and even shocking to American ways of thinking about war because of our unwillingness to see armed conflict as an inevitable part of the permanent rivalry between human groups.

He goes on to contrast the unrealistic American idea of total war and total peace with the Communist recognition of organized violence as a part of human competition, doing justice to the Communist's profound study of Clausewitz, the great Prussian military philosopher who so masterfully set forth the relation between war and policy. Next he sketches the rise and fall of limited war over the last three centuries and concludes with an account of U. S. national strategy since 1945.

Kissinger's book is a digest of a lengthy panel discussion by a group called together by the U. S. Council on Foreign Relations. Although he does not go as fully into historical details as Osgood, he covers substantially the same field, with greater emphasis on the immediate military situation, and suggests a radical reorganization of the U. S. armed services.

Noting the confusion in military thought which aggravates the deplorable squabbles between the Air Force and the other two services, his first two chapters rightly conclude that the national interest would be better served by a clearer over-all strategic doctrine. He shows that the present assignment of rôles and missions among the three services produces overlapping and duplication of effort, but he is on less sure ground in his last chapter when he suggests that the existing three services be retained only as administrative and training commands, each service with its own uniform and schools.

IN accordance with the nature of all-out nuclear war and the need also to prepare for limited war, he would set up three operational commands which would cut across the lines of the existing services. For all-out war there would be a "Strategic Force" composed of the Strategic Air Force, the Continental Air Defense Command, the large naval aircraft carriers, and such Army troops as might be required for the defense of overseas bases.

For limited war there would be a "Tactical Force" composed of most of the Army, the Tactical Air Command, and Naval forces for the transportation and support of the Army and the Tactical Air Force. The "Strategic Force" should not be used for limited war since that would diminish the retaliatory power which would keep the war limited.

In view of the special technique of antisubmarine warfare, there would be a third command composed of the ships and aircraft organized for that mission.

After these hasty glances at so much interesting material, let us look further at some of the leading ideas suggested.

First, would we be better prepared for nuclear war if we adopted Kissinger's proposed reorganization? Indeed, a future war involving long-range city

bombing would differ fundamentally from one which did not include such bombing, and today certain weapons and military instruments are adapted chiefly to one form of war. Consequently there is an appearance of logic in the proposal.

On the other hand, the logical picture blurs badly as soon as one examines it closely. The mere names "Strategic Force" and "Tactical Force" show confused thinking because strategy and tactics cannot be divorced any more than attack and defense.

For instance Kissinger puts the Tactical Air Command in his "Tactical Force," but in an all-out war involving long-range city bombing comparatively short-range fighter aircraft and even shorter-ranged missiles would carry the burden of defense.

Isn't the defense of U. S. territory and that of our allies as "strategic" as long-range bombing itself?

Then there are the large naval aircraft carriers which Kissinger would put in his "Strategic Force." Incidentally, he would give that force an Air Force general as commander in chief—which recalls unhappy controversies between the services and ignores the possibility that a "Missile Force," which might or might not be commanded by an Air Force general, may within a few years begin to take over much of the task of long-range bombing from the manned bombers of the present Strategic Air Force.

RETURNING to the large "attack" carriers, of course their airplanes can bomb inland objectives as naval aircraft did in Korea. Consequently those airplanes might add considerably to the retaliatory bombing which would follow long-range nuclear bombing by the Soviets.

Metaphorically speaking, it would be a case of "all hands to the pumps" as when an old-fashioned sailing ship sprang a leak. But how it would improve matters to put the carriers under the same command in peacetime is not clear. The public has no reason to believe that the Joint Chiefs of Staff have not already provided for coördinated joint action in case of a sudden emergency, and in the unlikely event of their not having done so they could do it tomorrow.

Next, is limited war with tactical nuclear weapons possible? In other words, could such weapons be used against an enemy's armed forces without doing vast damage to civilians? General Groves, whose qualifications no one will dispute, categorically says that it could be done—provided of course that it were possible to overcome the political factors which would make it difficult to limit any war between great powers irrespective of weapons.

In this, history bears him out. The limited wars of the Roman Empire were fought with the same weapons which had been used in the great wars of the Mediterranean world for nearly four centuries before Augustus, and in the eighteenth century the armament of limited wars did not greatly differ from that used either in the horrible religious wars which preceded them or in the vast French Revolutionary-Napoleonic War which followed them.

General Groves adds that violations of an announced intention to use only nuclear bombs of less than a certain size and power could easily be detected, adding that he himself saw Doctor Fermi estimate within a small limit of error the power of the first experimental atomic bomb exploded in the United States, which that scientist did without the help of any instrument of precision.

As to the allegedly harmful genetic effects of nuclear explosions upon future generations, the general notes that the inhabitants of the city of Denver, Colo., who live about a mile above sea level, are therefore permanently exposed to more radiation from the cosmic rays than those of New York City. And yet, although Denver was founded in 1859, had a population of about 134,000 in 1900, and is approaching half a million today, no genetic weakness there has ever come to his attention.

That "clean" nuclear bombs can be exploded without appreciable chance of distant radioactive fallout seems quite probable. To Khrushchev's recent statement that any bomb which kills women and children is a "dirty" weapon, it is enough to answer that women and children in great numbers have been killed not only by "conventional" air bombing but also by other weapons from the beginning of human record until the other day in Hungary.

ALL told, therefore, it is certainly worth while to consider how nuclear warfare might be limited. And since Soviet nuclear power is accompanied by so numerous an army equipped with "conventional" weapons it would certainly profit the West to use its considerable power of manufacturing atomic explosives as tactical weapons. Consequently, as Professor Blackett says, restrictions on area weapons and targets should be publicly discussed and clearly understood beforehand.

Internal Western political difficulties are the real obstacle to providing forces capable of discouraging or winning limited wars while maintaining the long-range bombing forces with which we discourage all-out nuclear war.

Can the Western populations, already semisocialized, be persuaded in peacetime to make the efforts and sacrifices necessary to prepare adequately for both forms of war without spending themselves deeper and deeper into socialism? If so, who will persuade them? These are questions which the future will have to answer.

"Every limitation of war—as to area, weapons, targets, and in general the proportion of national resources to be committed—must be mutually acceptable or else the war would not remain limited. Also this mutual acceptability must be based solely on mutual unwillingness to begin all-out nuclear war.

"The restrictions should be clear, simple, and fully understood by being publicized beforehand. The mutual agreement to observe them would be tacit and would depend more upon actions than upon words. Both sides . . . would be free to act unrestrictedly if the enemy began to adopt an unrestricted policy."

Perpetual Preparedness

The growing threat of Communism to the free world necessitates that we maintain stable air, sea, and ground forces constantly exercising their deterrent effect and retaliatory potential

Gen. Thomas D. White

TODAY, Americans in the armed forces, in this country and in many other parts of the world, are standing guard over our security. Throughout the non-Communist world, men and women of the Air Force are on duty. Units of our Army are deployed on three continents. Fleets of our Navy's forces are standing by in every ocean. Wherever they are needed in the free world, the men and women of our armed forces are working together in the cause of international stability and peace.

This is a condition without parallel in all our history. Never before has it been necessary during peacetime to keep ourselves ready for war on an instant's notice.

IT was only ten years ago that our cities, towns, and villages lay open to the skies. They were undefended against attack from the air because no such disaster was then possible. We were secure in the protection of the oceans that separated us from any possible enemy. We knew that if war should break out, if it should become necessary to fight, there would be a relatively safe period of time for us to mobilize our forces, train them, and get them into position. Furthermore, while we were building up our fighting forces, the industries of the Nation would have time to produce the weapons, equipment, and supplies that we would need.

General White is Chief of Staff of the United States Air Force. This article is based on an address by General White on Armed Forces Day 1957.

Today we cannot look to the oceans to guard us. Nor could we count on having time, after a war began, to mobilize vast fighting strength and build up huge supplies of weapons and equipment, as we were able to do in the two World Wars. Modern air power has changed all this. It is now possible for war to begin with air attacks directly against the sources of a nation's strength, including cities and industries. So it cannot be assumed that there again will be a comparatively safe period for mobilization after war begins. The very first air operations could possibly be so powerful that they would be decisive.

We are opposed and threatened by ruthless Communism. In control of this power are men who are openly dedicated to the ultimate destruction of our form of freedom and to the incorporation of all nations and all peoples into the Communist pattern.

There is little or no evidence to indicate that the pressures, tensions, and alarms which are caused by the building of great military strength by the Communists will diminish appreciably in the near future.

It is not likely that there will be a quick solution to these troubles. This being so, the requirements of security for our cities and homes will permit us no alternative to maintaining a level of military strength sufficient to counter the threat of Communist power. The risks of not doing enough would be too great to accept.

The Soviets began rebuilding and modernizing their military forces as soon as World War II ended—at a time when other nations, and particularly the United States, were eagerly turning toward peace. They have continued to emphasize military power ever since.

THE Soviet Army has a constant strength of 175 divisions, 65 of which are armored and mechanized.

The Soviet Navy in the last ten years has moved up from seventh place to second place among the world's fleets. These forces include some 500 submarines and a shore-based air arm of 3,000 jet aircraft.

The Soviet Air Force's exact strength is a closely guarded secret, but it has in operation more than 20,000 combat airplanes—most of them modern jet bombers and fighters. We know also that the Soviets have in production airplanes that are similar to the latest types that we have. Over and above all of this, they are making a major effort in missile experimentation and development.

On the basis of these facts we have

no choice but to conclude that the Soviets are building military forces capable of great striking power and that this striking power is composed predominantly of long-range aircraft, missiles, and nuclear weapons.

To summarize: The Communist leaders who are sworn to win domination over the free world—and that includes us—now have at their command airplanes and atomic weapons which they could use to launch attacks directly against targets in this country. If the principal targets were cities, and if the attacks were successful, millions of American men, women, and children would die, and those who survive might expect nothing better than a miserable existence under Communist tyranny. This is why our Government has built and maintains our military power at its present level.

Atomic war is the awful possibility that we must not allow to happen. I believe that it will not happen—if we keep our armed forces sufficiently strong and if we keep our courage and determination high.

These two "if's" are very large ones. In fact, as the struggle against Communism goes on, it may be that these two "if's" will turn out to be as important as any questions with which our country has ever grappled because they are concerned with survival—with the maintenance of defenses for freedom.

AS to strong defenses, I do not mean that we must arm ourselves only to fend off an enemy attack. If our forces were built only for defense, we would be like a boxer who goes into the ring prepared only to counter the blows of his opponent but unable to strike a blow of his own. Sooner or later the offensive fighter would find a way to penetrate the defense, and that would be the end of the defensive fighter.

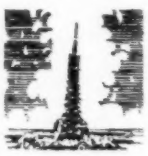
The surest way to prevent war is to be able to assure any enemy that if we are attacked we will counter with a knockout blow. If a potential enemy knows that war will bring him nothing but his own destruction, then we believe that no enemy will start a war as a calculated action. But we cannot run the risk of assuming that our opponents will act wisely or logically—or even sanely. Nor can we rule out the possibility that through accident, or a mistake in judgment, war will be brought on.

However, if we have the kind of military power I have described, and if it is clear to the whole world that we are prepared to use it, and if our policies make it clear that we are determined to use it if necessary, then we will have done our utmost to prevent war. And if it turns out that war is forced upon us, we will be in a position to fight with the best chance of winning.

These are dreary thoughts to impose upon you, but I have a reason for doing so. It is because there are many ways in which we could lose the position that we must maintain if we are to have peace. We must always remember that and never panic.

Recently we heard loud voices from the Kremlin, the headquarters of the Communist conspiracy, blustering and threatening in an attempt to panic us and the nations—many of them little nations—that have joined with us in the fight to prevent any further Communist aggression. We did not panic, and neither did our gallant free-world allies.

We understand and we can meet such attempts to shake our nerves. But there are other ways that can be used to unnerve, to hypnotize, and to paralyze us so that we drop our guard and stand with insufficient power before our enemies. These ways are often not so easy to recognize and therefore not so easy to counter as the crude bluster of a bully.



I am thinking now of such things as propaganda which urges us to abandon our nuclear weapons lest we destroy the world in our efforts to save ourselves. Perhaps some day it will be possible to outlaw these terrible weapons and use the atom only for constructive purposes that will benefit all mankind. But that day will come only when we are assured that no potential enemy has or can build secret atomic weapons that he could use against us without fear that we could retaliate with a strength he could not hope to withstand.

It is easy to persuade ourselves to believe the things that we would like to believe. That is why it is so important that we not be hypnotized by the sugar coating while we ignore the poison pill of Communist propaganda.

WE have been exposed on more than one occasion to propaganda which paints the rulers of Communism as men who would like to live in peace with the rest of the world if others only would permit them to do so. Little Hungary believed in the sincerity of the Communist claims and paid for it in the blood bath that still goes on. Poland has had experience with Soviet propaganda. So have Latvia, Lithuania, Estonia, Czechoslovakia, Rumania, Bulgaria, Yugoslavia, Albania, China, Korea, and Indochina. There should be enough examples to make anyone cautious.

If we look around us, keep our eyes open and our wits about us, we will not be maneuvered off guard by Communist propaganda, even when it is cleverly disguised. But there is another danger that is not so easy to identify, and that could be as fatal to our security in the long run as foreign propaganda. This danger lies in our home-grown fears and apprehensions.

Specifically, one of the great dangers, in my opinion, is that many, losing sight of the dangers that we face, will incline to the belief that defense is too expensive and will then get caught up in some kind of snowballing trend to reduce our spending for our own military strength and for the strength of our allies.

There is no basis for trying to argue that modern weapons do not cost a great deal of money. Across-the-board the costs are higher than they used to be. But that's not a peculiarity of weapons or military equipment. The costs of just about everything connected with modern life are higher than they used to be.

We are spending a great deal for defense, and it is understandable that someone taking a casual look at the dollar outlays may conclude that there

must be some extravagance somewhere. But that is not necessarily true.

Air power, for example, is not an extravagance. It is a necessity. As a rule, the items that go to make up air power —the aircraft, their equipment, and the installations—all cost more than they once did. But we are getting more in return for what we are spending than we got a few short years ago.

A B-29 bomber, the mainstay of the air forces in World War II, cost over $600 thousand. The B-52, the modern, all-jet heavy bomber with its nuclear bomb-carrying capabilities, costs about $8 million. While the B-52 costs about fourteen times as much as the B-29, it would take two or three thousand of those B-29's to inflict as much destruction on any given target as could be delivered by a single B-52 carrying one nuclear bomb.

Just to give you an idea of some of the factors that are in this comparison, we lost 9,950 bombers in our European operations during World War II. All of these were not B-29's, of course. However, the total does indicate the huge costs involved in conducting the kind of mass operations that the weapons systems and munitions of that day made necessary.

WE would be financially unable to afford the air power that we have today if we tried to acquire its equivalent in terms of the airplanes and weapons of World War II. The fact is that air power, when viewed as an over-all concept, is less expensive today than it was during World War II.

We are faced with this heavy spending for our Air Force today because we must maintain an Air Force in-being that is capable of fighting a major war on a moment's notice and with little prospect that it would be reenforced after the fighting begins. Yet, we are able to maintain this great force with one-third the aircraft and personnel that we had at the peak of World War II.

"We have been exposed on more than one occasion to propaganda which paints the rulers of Communism as men who would like to live in peace with the rest of the world if others only would permit them to do so. Little Hungary believed in the sincerity of the Communist claims and paid for it in the blood bath that still goes on."

Our air defense will be strengthened by extending the radar warning systems farther eastward and westward to give us an early alert to any attack and by arming our interceptor aircraft with atomic missiles.

Additional long-range, intercontinental bombers will be purchased for the Strategic Air Command. I would like to give a few facts about SAC, which is the hard core of our deterrent power.

The American taxpayers have nearly $18 billion invested in SAC bombers. This investment includes several thousand bombers now at SAC bases across the globe. They range from the F-84F, a strategic fighter which can double in brass as a bomber, to the B-52 long-range bomber. These planes are scattered about at more than thirty U. S. bases and at bases overseas.

All these planes are controlled from the Omaha headquarters of SAC through a vast system of global communications. The efficiency of this system can be indicated by its ability to

get in touch with a single airplane flying anywhere around the globe in a matter of minutes.

Each squadron within SAC has its own war plans which it would carry out if necessary. Each combat crew knows its targets and alternates, and crews already know what the target looks like, visually or on radar. If war comes, SAC will rely on high-speed strikes at targets all over an enemy country. Strikes will be mounted from U. S. and overseas bases. These capabilities, in sum, make SAC the most powerful striking force in the world today.

The Tactical Air Force also will receive new aircraft and with their increased mobility will be able to reach distant emergency areas quickly and hit enemy targets as required.

Recently two flights of Tactical Air Force airplanes—F-100C SuperSabres—

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flew nonstop with aërial refueling from George Air Force Base in California to an exercise area in the Caribbean and back again. The total distance was 3,900 miles. Upon reaching the exercise area at their assigned time the aircraft simulated a bomb drop—as if they actually had been summoned to an emergency area for that purpose. This flight demonstrated the great operational mobility of our tactical-type air forces.

The Air Force—like any efficient enterprise—strives for stability and continuity in its operations. That is the economical way to do business—and on that point I would like to cite no less an authority than the Chairman of the House Armed Services Committee—Representative Carl Vinson, and I now quote from a statement he made during a recent hearing before his Committee:

"I know you have all been impressed, as have I, by the constant emphasis placed upon the importance of our stable-force concept. The Nation and the world know that we will no longer engage in the foolish and expensive game of mobilizing and demobilizing as the trend of world events fluctuates."

HIS observations, in my opinion, reflect a very great understanding of the problems of providing and maintaining military power with the greatest practicable economy.

In some areas of the world, the light of liberty has been extinguished; in others, it flickers fitfully. Here, in this great country, it shines brilliantly. It is our solemn duty to keep it shining.

Men against the Snow

Personnel of the United States armed forces, aided by modern equipment, conducted Operation Deep Freeze in the Antarctic to set up bases for scientific explorations during the Geophysical Year

E. B. English

LIGHTED only by glittering stars and an occasional, spectacular Aurora Australis, seven small Antarctic outposts battened down for the long, cold winter's night. The sun had set below the northern horizon months ago, not to reappear again until October. With it went 12 ships, 40 aircraft, and the more than 3,500 Navy, Coast Guard, Air Force, Army, and Marine personnel who had bustled around and across that desolate, ice- and snow-covered wasteland.

Only 168 Navy men and 148 scientists remained behind, scattered at 5 stations around the continent and at 2 stations inland—one 10,000 feet high at the geographic South Pole, the other high on the Rockefeller Plateau.

Now the men could relax and turn most of the work over to the scientists, retaining only routine watches, maintenance, supply handling, and the running of communications stations. An almost impossible schedule had been challenged and conquered, and the United States was ready for its scientists to carry out their assignments of observation and investigation during the 1957-1958 International Geophysical Year.

FREQUENTLY the tasks had seemed insurmountable, the hazards too great. One of these was the establishment of Byrd Station in Marie Byrd Land, high on the Rockefeller Plateau. More than 500 tons of cargo had to be moved the 660 miles on 20-ton sleds pulled by Caterpillar low ground pressure D8 tractors, 72,000-pound machines with extra-long, extra-wide tracks, exerting less than four pounds' ground pressure per square inch.

Mr. English is manager of the governmental division, Caterpillar Tractor Company, Peoria, Ill.

Late last season, before the 1955-1956 sun set, a team of Weasels, personnel carriers, and tractors, moved out to mark a trail and establish a fuel cache at the 360-mile mark in preparation for the coming year. But 200 miles from Little America V they encountered a heavily crevassed section. Cracks large enough to swallow the Queen Mary interlaced a 5-mile belt where the Ross Ice Shelf meets the mountains rising to the Rockefeller Plateau.

Unable to go around the crevasse belt, the Seabees started across, gingerly feeling their way along. When a crevasse was located, it was blasted open with explosives and filled with snow. Backing up from one crevasse to pick up another blade load of snow, a tractor driven by Max Kiel plunged backward 100 feet down into another crevasse no one had seen, crushing the 22-year-old Portland, Oreg., Seabee in the cab.

This year the men came back with a newly designed crevasse detector, developed in the Arctic. Mounted on a Weasel, a light, tracked vehicle about the size of a jeep, the detector utilized two dishpan-shaped transmitters towed astern to send 3,000 volts forward into the snow and ice. Five more dishpans on booms slid ahead over the snow, receiving impulses from the transmitters. Voids under the surface, both across and parallel with the trail, were easily detected and by-passed, or blasted open and filled with snow if by-passing was not possible.

Sixteen days and 4,700 pounds of explosives later, the battle with the dangerous chasms had been won, and the party sped on. Maj. Merle Dawson, Army Transportation Corps, from Williamsburg, Va., marked the trail every fifth of a mile with red flags on bamboo poles, lining up the poles through binoculars for a course straighter than possible with a compass.

As the trail-blazers neared the site of the proposed station deep in the heart of Marie Byrd Land, the Antarctic's first tractor train set out from Little America V on the morning of December 5th. Six tractors, each pulling two 26-ton sleds, a seventh pulling sleeping and messing wannigans, and a Weasel delivered 160 tons of cargo for the construction of Byrd Station, 632 miles distant, in just 18 days and 2 hours, across the crevasse belt and up 5,000 feet onto the Rockefeller Plateau.

Extreme caution had to be exercised

in crossing the crevassed area. Only one 37-ton tractor at a time, pulling one 26-ton sled, would venture up the 7½-mile trail. Then CWO Victor Young, U.S.N., of Wickford, R. I., in charge of train, would wait for the "nervous" ice to settle before sending another load across. As an extra precaution, operators walked behind their tractors, guiding their behemoths by reins attached to steering and master clutch levers. Then if the tractor should break through, the men would have a chance to get clear.

WHEN the train safely reached Byrd Station, the men found thirty tons of fuel, accurately dropped at the site by Navy and Air Force airplanes, waiting for their use on the return trip to Little America V. Before the sun set, two more round trips were made to deliver the needed 500 tons of cargo.

Meanwhile, the other members of Navy Task Force 43, under the command of Rear Adm. George J. Dufek, had weathered the darkest hour of Operation Deep Freeze. Rising temperatures and dwindling fuel supplies had forced the Eighteenth Air Force to withdraw its C-124 Globemasters from the McMurdo Sound air base to New Zealand. A New Year's Day storm with hurricane intensity drove accumulated ice against the U.S.S. ARNEB (AKA-56), then off-loading supplies for the Cape Hallett Station, 400 miles north of McMurdo Sound.

Ice had packed in this area to the extent of 200 square miles. Pressure ridges in the ice sprung bulkheads and slit the hull below the water line, flooding several compartments. The icebreaker U.S.S. NORTHWIND (WAGB-282), struggling to the aid of the ARNEB, lost a blade from her starboard screw.

ON the opposite side of the Antarctic continent, trying to reach Bowman Peninsula to establish the Weddell Station, an icebreaker and a cargo ship were stuck in the treacherous ice, 370 miles short of their goal. Ice slush froze around the ships as the sun sank low during the night hours. The icebreaker U.S.S. STATEN ISLAND had lost a blade from one of her screws and had used up more than half her fuel unsuccessfully battling the ice; the U.S.S. WYANDOT (AKA-92) had worn off the tips of all her screw blades on the crushing ice, reducing her speed to 10 knots.

And the season was running out fast. In previous years, three ships had been crushed by the ice in these waters.

But lowering temperatures and a team of tractors, working around the clock, readied the air strip for the return of the Globemasters on February 10th. The U.S.S. NESPELEN (AOG-55) arrived on New Year's Day with 540,000 gallons of aviation gas. Friendly winds from the south drove the ice to sea, freeing the ARNEB and the NORTHWIND. By lowering a heavy barge over the side and shifting ballast, the ARNEB was heeled over, exposing the ruptured hull for repairs. And favorable winds and rising temperatures opened a passage to the Bowman Peninsula for the STATEN ISLAND and the WYANDOT.

History books received another entry on October 29, 1956, when Admiral Dufek landed at the South Pole, the first man to set foot there since the ill-fated Scott expedition forty-four years previously. Three weeks later, two other Navy R4D's set up the first colony at the Pole, comprising eight men, eleven dogs, and a few tents.

Then the Eighteenth Air Force moved in from New Zeland with eight C-124 Globemasters for the 1,500-mile round trip from McMurdo Sound. Under the command of Col. Horace Crosswell, the Globemasters began parachuting the needed 500 tons of supplies around the clock, weather permitting. The largest single load dropped was a Caterpillar low ground pressure D2 tractor. With the cab and track shoes removed, the machine weighed seven tons and was so large it barely cleared the sides of the elevator well. But the Air Force riggers had done a good job, and the tractor was operating in less than an hour.

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On its return to McMurdo Sound after this drop, the Globemaster touched down 120 feet short of the runway in high winds and swirling snow. Plowing through ice blocks, the nose wheel collapsed and propellers splintered the ice. But the 90-ton aircraft skidded to a safe stop. Five weeks earlier, a Navy P2V Neptune had crashed under almost identical circumstances, killing four persons aboard.

On the ground, with a force swelled to twenty-four men, Lieut. Richard A. Bowers, Quonset Point, R. I., directed construction of the Pole Station to accommodate eighteen men over the coming winter. With temperatures ranging from 25 to 35 degrees below zero and in the rarefied air of 10,000 feet altitude, men and machines could work at only 60 per cent efficiency. Even so, the entire camp was completed in only six weeks. Then the Seabees pulled back to McMurdo and the wintering-over party was flown in—eleven scientists under the direction of Dr. Paul Siple and seven Seabees under Lieut. (j.g.) John Tuck of Auburn, Miss.

ANOTHER record-setter of the South Pole operation was Air Force Sgt. Richard J. Patton, St. Louis, Mo. When air drops were stalled because parachutes failed to open or became disengaged, burying supplies up to 15 feet deep in ice and snow, Patton volunteered to jump to the station in an effort to find out what was wrong. Made in bad weather which prevented smaller aircraft, capable of landing on the snow, from climbing over the mountains, the jump by Sergeant Patton was the first such feat in Antarctic history.

The air strip from which the Navy and Air Force aircraft worked had been wrestled from the snow in two cold, dark months. First the Seabees had attempted to compact the snow into a hard surface, as they had done success-

(Continued on p. 438)

A low ground pressure tractor carries fuel from a supply area to Little America V Station over a trail safely marked by flags (Navy photo).

U.S.S. ARNEB unloads supplies into waiting sleds at Little America V. Tractors moved away from ice edge; retrieved sleds by cable (Navy photo).

Right, the first camp at McMurdo Sound clustered around Capt. Robert F. Scott's hut, built forty-four years earlier. A tractor moves down the "street" unloading supplies brought up from the ship (Navy photo).

An electronic crevasse detector, mounted on a weasel, charts a safe path for the 37-ton tractors and 26-ton sleds (Navy photo).

A low ground pressure tractor heads for a base pulling ten sleds loaded with supplies just flown in (Navy photo).

A lightweight tractor, air-dropped at the South Pole, is used to haul a load of fuel drums from the drop area to the camp (Navy photo).

At Hut Point, where the McMurdo Sound air base was established, technicians set up a ground-control-approach unit to help bring in aircraft caught in storms (Navy photo).

fully in the Arctic and on the previous expedition at Little America. But this time they could not get adequate compaction to support the 90-ton Globemasters.

Next they tried flooding an area with sea water pumped up from below the ice—but the blowing snow formed a slush that froze into a treacherous surface with soft pockets. So they were forced to shift to a third method—clearing the snow from the ice.

But only one tractor, a standard D8, was available to clear the 8 to 14 feet of snow from the proposed strip, 300 feet wide by 6,200 feet long.

A second tractor had plunged through the ice the previous January, carrying Richard Williams, a 22-year-old Seabee from Appenheim, N. Y., to his death when the temperature had risen to 40 degrees. Williams had been hauling supplies from shipside to the camp when a crack opened up in the ice and the tractor plunged 600 feet to the ocean floor.

It was already July 23rd, and the planes were scheduled to start the fly-in from New Zealand October 13th. So the Seabees climbed aboard "Pogo," as they had named their only hope, and began around-the-clock snow clearing. Portable generators lighted the scene, for the sun would not rise until September 25th. The temperature ran to 60 degrees below zero, and men had to be replaced every forty-five minutes.

WHEN the ARNEB and the NORTHWIND returned to Cape Hallett after the New Year's Day storm, they found the penguins had retaken the beachhead from the Seabees. The battle had begun with a landing on the west side of the volcanic-ash-covered bay. The Adelie penguins, guarding their recently hatched, fuzzy chicks, covered the triangular beach.

First, one hundred square yards were fenced off. Then sailors gathered the squawking youngsters into baskets while their shipmates threw nets over the struggling adults. The ground was a scene of bedlam, the air pierced by sharp, indignant cries until the compound was clear.

Then a storm struck. When the men returned, the fence was down and the penguins had reoccupied their beach. So the sailors started over again, and this time they won. When a tractor bulldozed the area clear for buildings, it was found that the ground was a mixture of gravel and penguin guano to a great depth, the residue of centuries of penguin habitation.

"The air strip from which the Navy and Air Force aircraft worked had been wrestled from the snow in two cold, dark months . . . but the 'can do' men of Operation Deep Freeze beat both the elements and the schedule."

AFTER three weeks in Cape Hallett the ARNEB and the NORTHWIND headed south of McMurdo Sound. There the ARNEB was joined by the world's largest icebreaker, the U.S.S. GLACIER (AGB-4), and the cargo ship U.S.N.S. GREENVILLE VICTORY, for the assault on Budd Coast to establish Ellsworth Station, south of the Indian Ocean.

Once again the heavy pack ice fought back. Three times the GLACIER crunched through the pack, only to reach a dead end at an ice wall. On the fourth try, late in January, when despair was near in the face of a waning season, the ships broke through the 125-mile belt of ice.

But a 15-foot ice shelf still stood in the way of landing operations. First men went ashore, and with picks, shovels, and twelve tons of explosives ripped a path through the shelf. Then a Caterpillar Traxcavator was brought in on a landing barge to shave a gentle ramp for the heavier tractors. Two weeks later the camp was completed—sixteen buildings, a forest of radio masts, and odd-shaped domes and towers. Construction had been expected to take at least seven weeks.

And so camps were built. Ice and snow, wind and cold, all had combined to repel the invaders. But the "can do" men of Operation Deep Freeze beat both the elements and the schedule.

As the sun circled lower, the ships, airplanes, and most of the men withdrew. Only a little over 300 men remained behind, occupying the seven camps built during the previous two summers. Only the emergency station on Beardmore Glacier, built for support of aircraft on flights to the South Pole, had been abandoned.

Today, as the darkness embraces the land, another Antarctic miracle has taken place. Electric lights shine, turning each camp into a glistening city under the snow. Electricity for lights, for communications, for freezers and stoves, for the thousands of instruments needed by the scientists and for the comforts of home—is provided with round-the-clock reliability by thirty-four electric generator sets.

Nearly 20,000 feet of wire was needed for the 36 buildings at McMurdo. And good grounds are impossible, particularly through the 800 feet of ice the Little America V Station sits on.

In addition to supplying electricity, the generator engines are used for snow melting and heating. Exhaust gases pass through snow melters, producing water for cooking, drinking, and washing. In some instances the electric sets are located adjacent to the heads, and a fan blows engine heat down box tunnels to keep the water pipes from freezing during the many months of subzero weather.

THUS the construction phase of the Antarctic operation has been completed. Now the scientists have taken over to study the aurora, cosmic rays, geomagnetism, glaciology, ionospheric physics, meteorology, rocket exploration of the atmosphere, seismology, and gravity. These findings will be incorporated with those of the other hundred stations the United States has from pole to pole and from the stations of the other forty-one nations around the world coöperating in the International Geophysical Year.

Already results are being realized. The Magnetic South Pole is believed now to be located 600 miles east of its presently charted position. This knowledge will permit more accurate correction of magnetic compasses. Weather information is being gathered to help predict weather around the world more accurately, and other results will follow in the very near future.

The Navy's Task Force

Organization of naval forces by task and type is designed to take advantage of the mobility and freedom of action that the sea and the air afford to ships and aircraft in fast-moving, modern warfare

Rear Adm. John D. Hayes

DURING World War II the expression "task force" in connection with the fast carrier operations in the Pacific caught the imagination of the American people. This phrase has now become part of our language. Other armed forces have adopted it, and some Government activities like the Hoover Commission have applied it to their working committees. It also serves as a name for a line of commercial trucks. Such imitation is flattering but not always accurate.

The phrase, "task force," in the working language of the U. S. Navy has a limited and special meaning. It is but one of a group of terms used in connection with a system of organization which the Navy has developed for managing its ships and aircraft. Other terms in the same category are "task group," "task unit," "type command," and "operational and administrative control."

THE system of organization which employs these expressions is designed to take advantage of the mobility and freedom of action that the sea and the air afford in war. Its success has made it the admired tool of fast-moving, modern warfare.

Naval officers, as a rule, understand this system although they have a hard time explaining it to people outside their own service. The naval profession does not have a dictionary of its own, and the definitions in the Dictionary of United States Military Terms for Joint Usage are of little help in understanding this concept of organization. Adm. W. H. P. Blandy has left the best published explanation of it. After describing what he calls the organic or component command system used by the other services, he says:

Admiral Hayes is managing editor of Shipmate, *the U. S. Naval Academy Alumni monthly. Before his recent retirement, Admiral Hayes was on the faculty of the Industrial College of the Armed Forces, Washington, D. C.*

"The Navy subscribes to the task force system and had used it within the Navy before World War II—operating forces of composite nature and of less than fleet size having frequently functioned on command lines which temporarily disregarded administrative command structure. During the war, the principle was exploited by United Stated naval forces to the utmost. Administrative naval commanders were usually not even in the forward areas."

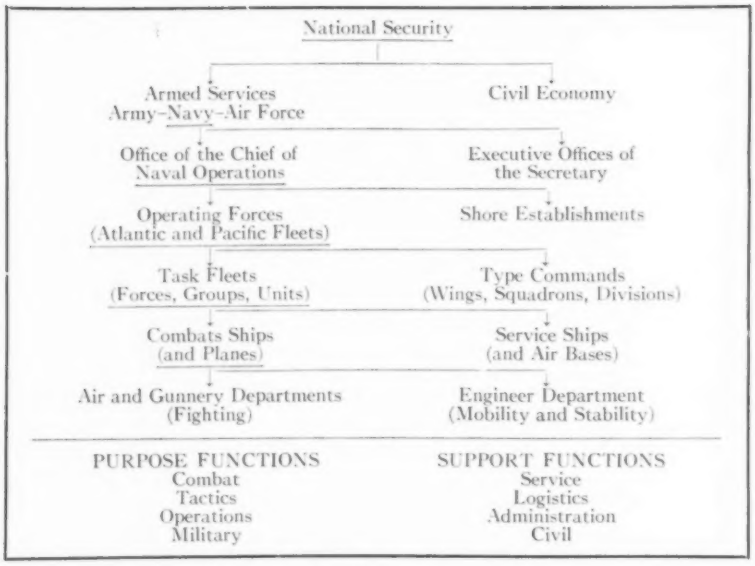
The Navy has no official name for this method of organizing its fighting forces. Admiral Blandy called it a "task force" system. The broader term, "task type," is preferred here. In any case, with this system every ship's captain works for two bosses. He is under the *administrative control* of a *type* commander who is responsible for the ship's upkeep, supply, discipline, and training. He is also under the *operational control* of a *task* commander who is responsible for accomplishing some task within the Navy's mission as expressed in an operation plan or order.

SHIPS are always under their type commander and are assigned as needed to a task commander by a common superior. Task commanders are concerned with purpose functions. Type commanders are concerned with support functions.

This separation of task and type duties has evolved from both experience and change. British sailing fleets in the wars with France were essentially "task forces." The Navy Board prepared the ships while the Admiralty assigned them to the various fleets. Sailing navies had only two basic types, ships of the line and frigates, and admirals did not have to worry too much about logistics.

In our Civil War, however, the variety of vessels employed and the inadequate system for administering them caused flag officers to become enmeshed in logistic details—coal, collisions, and court martials, to name a few. Only David D. Porter seemed able to keep himself free of them.

Steam, armor, improved ordnance,



Military dualism in naval organization.

powered flight, and submersibles all expanded the potentialities of sea warfare. The number of warship types increased with this expansion, and commands were established to develop the capabilities of each new type. Type commanders during the early stages controlled both administration and operations, and as the number of ships of the type increased they were formed into divisions, squadrons, and, in some cases, flotillas.

THIS single-line command system, desirable as it was in principle, was found to be unworkable when the type was ready to take its place in the fleet. Navies are strategic instruments, and naval deployments are necessary in both peace and war. The size and location of each deployment is determined by requirements of foreign policy and by the capabilities of the ships available. Ships of various types have to be disposed in varying numbers into composite or task groupings.

Permanent assignment into these composite groups is not practicable because tasks are forever changing and ships can only perform them when operationally ready. Ships have to be withdrawn from this operational status from time to time for repairs, upkeep, and training. During these periods it is best that ships be under their type commanders.

Even when ships are operational and doing task work it was found that type commanders could still perform many of their functions and thereby relieve task commanders of many diverse logistic responsibilities. The integrated and independent nature of a ship allows this division of command responsibilities.

The Naval War College formalized this task-type idea into a system. It did so by teaching military logic through its "estimate of the situation" technique. Solutions to problems of naval warfare arrived at by this technique give a mission to be accomplished, tasks to be performed, and the forces necessary to perform them. The product of the "estimate" is an operation plan.

As the War College thinking spread throughout the Navy, the practice of ships working under both an administrative arrangement and an operation plan gained acceptance. Radio provided the necessary communication channels for this dual control.

Gradually the practice grew of assigning ships to task units, groups, and forces as well as to divisions, squadrons, and flotillas. The functions of purpose and support became distinctly separated and the abstract idea of what may be called military dualism became understandable to naval officers.

The extension of the task principle to whole fleets as a means of strengthening diplomacy in peace and replacing it in war was proposed about twenty years ago by Vice Adm. J. K. Taussig. He had spent eight years at the Naval War College and like its founder, Admiral Luce, "saw strategy as clearly as most of us see a material object." He advocated that task forces of fleet size be based in the waters of Southern California, Hawaii, and the Canal Zone.

TASK fleets eventually were created during World War II. In the Pacific, the Third and Fifth Fleets performed the successive operations of the overall strategic plan. These two fleets were composed essentially of the same ships although this was not known by the Japanese Navy or the American public. Today the Sixth and Seventh Fleets are permanently based in the Mediterranean and Far East, respectively, but they are composed of ships temporarily assigned from the Atlantic and Pacific Fleets.

The Atlantic and Pacific Fleets are the basic administrative divisions of the Navy's fighting forces. In each are type commands—carriers, battleships, cruisers, destroyers, submarines, air wings, and service, amphibious, mine, and fleet Marine forces.

Each ship, aircraft, and Marine outfit is assigned to some division or squadron of its type command in one of these two fleets. It also may be assigned to a fast carrier, antisubmarine, reconnaissance, expeditionary, or other task element as conditions require. Service ships are similarly organized for mobile support.

THESE combat and service task units, groups, and forces are assigned to the operational control of commanders, Sixth and Seventh Fleets, who have strategic missions; to commanders, First and Second Fleets, who have fleet training missions; and to other commanders with special missions.

Naval task components sometimes pass to the operational control of other services as when Marine units are assigned to the Army or radar picket ships to the Continental Air Defense Command.

The same separation of functions characteristic of the task-type system is

also present within the complex organization of a ship's company—that "complete work of time and wisdom." In battle, the air and gunnery departments which fight the ship perform the purpose function while the engineers who keep the ship moving and afloat furnish the support.

The chart on page 440 shows that separation of purpose and support or military dualism is carried up through the entire structure of the Navy Department. The Navy as a whole is divided into the operating forces and the shore establishments. Dualism at the top level of the Department was first advocated by Rear Adm. Stephen B. Luce in the middle of the 1880's as a means of getting better military management for the Navy's growing number of modern ships. Admiral Luce called the complementary functions military and civil.

HOWEVER, this organizational dualism was not achieved until 1915 when the Office of the Chief of Naval Operations was established to complement the Bureaus. Secretary Forrestal extended this dualism throughout the shore establishment during World War II when such terms as "management control" and "technical control" came into use.

Today's Navy Department has the Office of the Chief of Naval Operations on the one side and the Executive Offices of the Secretary on the other. The latter include such offices as that of the Comptroller, Naval Material, Naval Research, and the Bureaus.

The concept of military dualism, of separating the functions of purpose and support, is already part of our national thinking about defense. Every citizen knows that the armed services perform only the purpose functions of national security while the whole economy provides the support. Military dualism has not yet been incorporated into the Department of Defense, but the increasing use of such co-terms as "combat and service," "tactics and logistics," "operations and administration," "military and civil" indicates a growing understanding of this principle.

Dualism is present in many phases of our everyday living. It exists in man's nature in the separation of body and soul. It is basic to the Christian religion where men are told to "give unto Caesar the things that are Caesar's and to God the things that are God's." In democratic political thought there are the complementary rights and duties of the individual and his state.

The opposite of dualism is monism. Monism in the military scheme of things is represented by straight-line command and the general-staff method. Philosophers have been arguing for centuries as to whether monism or dualism best denotes reality. American military people, perhaps without knowing it, have been arguing the same thing for the past decade.

THE administrative history of the Navy offers an excellent pattern for achieving military dualism within the Department of Defense. No revolutionary changes brought this concept into the naval service; it only came with time, patience, and, above all, understanding. The Bureaus of the Navy Department before 1881 were semi-autonomous, not unlike the three armed services today. Process in running the Department was given more attention than purpose.

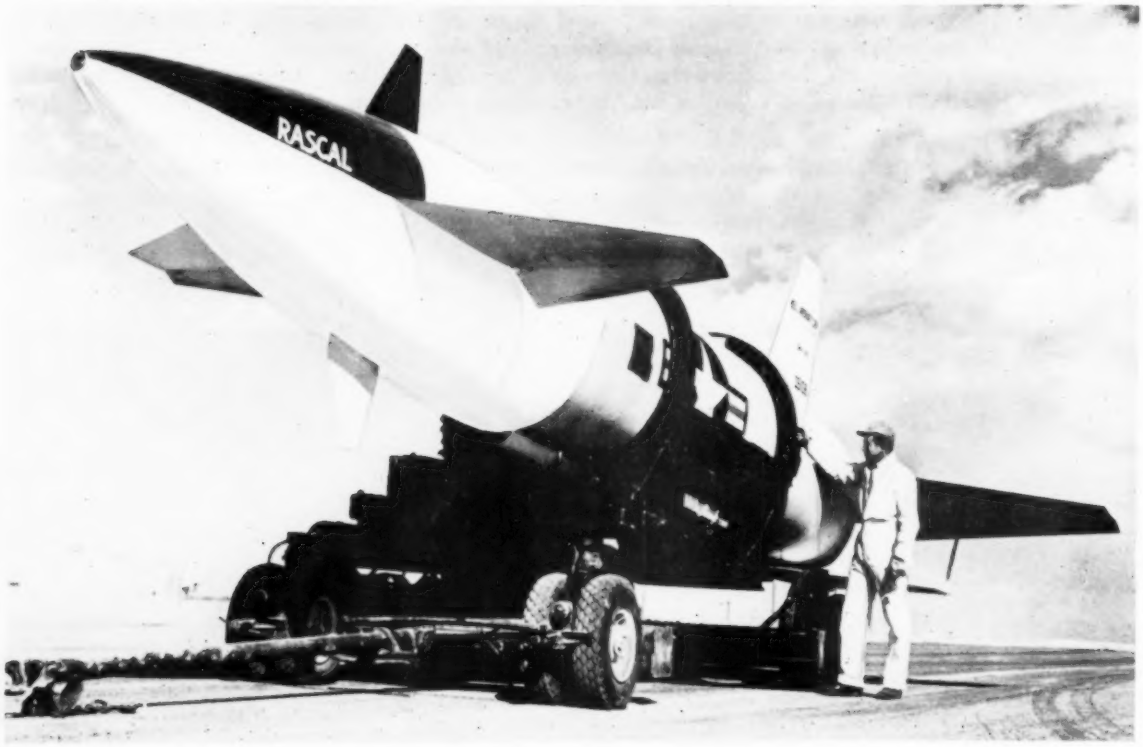
It took a generation of effort by far-seeing men like Admirals Luce, Taylor, and Sims, Secretary Meyer, and Congressman Hobson to get an office charged with directing the operations of the fleet and preparing war plans. Even this had to come in partial steps via the General Board and the aides to the Secretary.

The Bureaus fought long and hard to retain their executive powers, and for another generation after 1915 the Chief of Naval Operations had no statutory power to direct them. Nevertheless, while all this was going on, a modern navy was built and the United States moved into first place among the world sea powers.

The U.S.S. FORRESTAL under way during recent flight operations in the Caribbean Sea (Navy photo).

In the Missile Arsenal

A heavily padded Army Ordnance surface-to-surface Redstone missile, above, is being placed aboard an Air Force Globemaster cargo airplane for transport to a testing site. The Air Force air-to-surface Rascal, below, with a range of about 100 miles, is designed for launching from a B-47, B-52, or B-58 bomber and has inertial or command guidance (Air Force photo).



Hypermobile Musketry

Modern warfare will require lightweight general-purpose small arms with large ammunition capacity, effective at combat ranges, yet simple to operate and service and always reliable in action

Melvin M. Johnson, Jr.

DESPITE the feverish focus on missiles and mass destruction, weapons used by man versus man have been featured in all the wars of the past twelve years. Our own war with the Communists in Korea was no exception. The Communist countries continue to use so-called small arms, and of the fourteen post-World War II wars, eight have involved Communists.

There is every evidence that men will continue in combat against men. The H-bomb and the guided missile may deter or at least defer international annihilation, but brush-fire battles are undiminished.

In this era of H-bomb horror, there is much merit in the Lucid Look, certainly in the field of future firearms, else perhaps we should return to the pike, count on the knife, put our arrows to the strings, and bend the bow.

Since 1911 we have used the venerable Colt .45 automatic pistol of some 2.50 pounds. Its short-recoil action is made more positive by the momentum of a 230-grain, 900-foot-second bullet. Despite this available standard-issue pistol, our people in World War II and Korea carried a variety of personal arms including, from my own investigation, .25, .32, .380, and 9-mm. automatics; .38, .357, and .45 double-action revolvers.

Recently the NATO nations standardized on the 9-mm. cartridge. The Army studied some double-action automatics but found insufficient realistic advance to warrant change from the M1911 .45. Aircrews shifted from the heavier .38 revolver to lightweight .38 types. Some forms of aircrew "survival" weapons with folding stocks have been adopted. In general there remain many military missions for holster handguns.

Over the past forty years we have seen the introduction of the submachine gun or machine pistol, called tommy-gun and burp gun, and various forms of "carbines" such as our own M1 and M2, the German MP44, and the recent Russian type. Most of these weapons are merely glorified pistols for they shoot pistol-power ammunition such as 9-mm. or .45 automatic. The U. S. carbine cartridge is somewhat more powerful with a 110-grain bullet at 1,900 foot-seconds. The German MP44, which has been imitated by the U.S.S.R., uses a 7.92- or 7.62-mm. short or "Kurz" load, roughly 120 grains at 2,350 foot-seconds. With this type of cartridge there is medium-power rifle capability.

Colonel Johnson, U.S.A.R., Inactive, is the inventor of the Johnson semiautomatic rifle, Johnson machine gun, and other arms. He is currently a research consultant and technical adviser for government contractors and industries.

However, if we consider "burp" weapons in the 9-mm.-.45 auto-.30 carbine class, these have only pistol power ballistically. Their real advantage stems from shoulder operation which gives over four times the useful effective combat range versus hand-held pistols.

While their weight of five to ten pounds gives stability in firing, and their magazine capacity is tripled, full-automatic or "burp" machine-gun fire has been greatly overrated. It sounds deadly but climbs off the targets. Fast semiautomatic fire is far superior to "burp" bursts, even at close range.

ON semiautomatic an average operator can fire 5 shots in 2 seconds or less, which amounts to a rate of over 150 a minute. While burp guns have theoretical cyclic rates of 400 to 800 a minute, after the first shot most of the slugs go way off the target area in other than the most expert hands. This is all right if every gunner has a cartful of cartridges, but such supply is not possible in a hypermobile army.

Today there is a definite trend toward reduction in the varieties and types of small arms and ammunition. The advantages in simplification, cost, training, supply, maintenance, and manufacture are rather obvious. Our own Army has sought such simplification in attempting to develop one basic light rifle, caliber .30 (length reduced 0.55-inch from the standard caliber .30 rifle). This is to replace the rifle, pistol,

carbine, submachine gun, and, with heavy barrel and bipod, the Browning automatic rifle (BAR).

The Army's general-purpose 23-pound machine gun M60, is to replace the M1917 water-cooled and M1919 air-cooled Browning machine guns. This is the "family of weapons" concept.

The new M14 (T44) 8.50-pound automatic rifle modified from the M1 Garand with reduced-weight barrel and 20-shot magazine may replace the 9.75-pound M1, the 8- or 9-pound submachine gun, the obsolete 8.70-pound M1903 rifle, and, in M15 12-pound form with bipod, the 20-pound BAR. But it does not, at 8.50 pounds, replace a 2.50-pound holster-carried pistol or a 5.50-pound carbine.

There is much more need of a carbine plus pistol-holster weapon for today's hypermobility requirements than when the rifle-stocked carbine was adopted to replace the pistol and the rifle for personnel not performing as riflemen. The trouble with the carbine has been that "it looks just like a nice light rifle," which it is not and never was.

In the Pentomic Army and Marine Corps of today there are many more personnel assigned to missions which do not conveniently permit an added rifle load. They need both hands free.

IN the type of wars we will face, all such personnel need some weapon, easily carried, which they can fire from the shoulder with combat effect up to one hundred yards and in sudden emergency pull from a holster and operate at close range under a wide variety of circumstances.

The trends in technology and tactics are such today that some form of holster-stock all-purpose arm may become the sole survivor of the military small-arms family as we know it. Certainly much more must be done for hypermobile musketry if the equipment and technique are to pay off their weight with hits.

In my opinion the preferable pistol-subrifle, holster-stock type, should weigh about three pounds, hold some fifteen rounds in the pistol grip, loadable when partially or wholly empty with strip clips or single rounds without opening the breech. These loading features were in the Johnson guns of 1940, hence are regarded as realistic.

Five features would be desirable in a subrifle revolver: (1) Double action of the trigger for emergency operation, (2) no live round under the hammer, (3) no need for complicated confusing safeties never on when needed, (4) trigger-controlled ejection of "dud" rounds —if one does not fire you pull onto another, (5) easy thumb-cocking of hammer which shows, or can be felt in the dark, when the weapon is cocked. This last is a virture also of our M1911 and other hammer-exposed automatic pistols which lack most other features.

The weapon should not be full automatic but from prone at 100 yards should permit putting its 15 shots well inside a 10-inch bull's-eye at 100 yards in less than 20 seconds, shoulder-fired.

Considering all the factors of hit effect, accuracy, flat trajectory, weight of ammunition, recoil, and space, the preferable cartridge would be of caliber .220 with 35-40-grain bullet and about 2,800 foot-seconds' muzzle velocity in an 8-inch barrel.

Substantial data are available to support this load. For example, on weight versus the 230-grain .45 auto cartridge, you save one pound per 36 cartridges. With this load the weapon can be sight-set for 100 yards and effectively engage almost all combat targets.

The absolute maximum combat emergency range is 200 yards, shoulder-fired. In one hand the pistol is effective to 25 yards, in two hands with rest, if possible, to 50 yards. The pistol kick will be less than half of the present M1911 .45. The lethality at 25 yards will equal the .220 Winchester Swift rifle (4,100 foot-seconds' muzzle velocity) on a 250-yard target, which is of a high order. Jacketed bullets of course are considered as these are required under the Hague Convention which overlooked H-bombs.

Other features include a simple reliable advanced mechanism well protected from dirt, barrel change if possible for airborne packing, plastic barrel cover for forearm, quick attachement of holster as shoulder stock.

It is believed that over seventy per cent of our future armed forces will soon find they require such a weapon. But as of 1957 no "requirements" are to be found in the files.

AUTOMATIC rifles and machine guns date back some sixty years or more and hand-cranked guns such as the Gatling a full century. Several types of semiautomatic rifles, however crude, appeared over forty years ago. A German regiment tried the Mondragon in 1914 but at that stage this rifle was too unreliable, even though it embodied the U. S. M1 (1936) clip feed.

By 1940 the Russians had issued some Siminov and Tokarev semiautomatic rifles, the U. S. Army the M1 Garand. More recently several European nations have taken up the semiautomatic—models chiefly of Belgian, French, and Swedish designs, none especially novel in origin.

The primary problem in machine guns and rifles is the clash of critical high-power cartridge pressures with limited weight of the mechanisms. Thus the 9-pound semiautomatic weapon has been the toughest type to develop, the 20-pound autorifle or LMG less so, the 40-pound machine gun the easiest. However, belt feed for machine guns has been far from easy, hence little has been accomplished in belt-fed machine guns for many decades.

The reasons for this situation are perfectly obvious but often overlooked. All conventional machine-gun mechanisms depend upon momentum of the moving parts to unlock, extract, eject, compress return springs, and feed. Belt-fed weapons also must pull their heavy belt and provide power to force cartridges from the belt.

No matter how you slice it, heavy breech mechanisms are more reliable than light ones. Heavy breechblocks lose momentum in operation much less than light ones and are correspondingly more reliable in service.

The lightest belt-fed machine gun ever used in combat was the 25-pound German MG42. With its one-pound

The Army's M60 is replacing three separate weapons with one general-purpose, lightweight machine gun (Army photo).

bolt a cyclic rate of some 1,500 rounds a minute was essential for adequate reliability. Cyclic speed had to offset light bolt momentum loss. Reduced rate means more malfunction and increased rate increased breakage. It was noted in tests that the MG42 began to fold up with any substantial belt load to pull. Even our Browning air-cooled models have decided belt-lift limits.

THOUGH belts are a bogey in automatic arms, necessarily heavy magazine feed springs create plenty of anti-momentum friction to hinder bolt travel. Increase in magazine capacity means some increase in friction. But in the last analysis the ultimate enemy of the automatic is extraction, the root of rifle and machine-gun malfunction. At least heavier breechblocks tend to provide slower and more positive extraction than light ones—wiggle, contrive, concoct as we will.

Eliminate extraction, and if possible all reciprocating motion, and you will have something—but do not overlook the problem of manually extracting loaded or misfired rounds.

High-pressure ammunition presents the painful problem of extractable cartridge cases, by no means easy to produce. Soft brass cases are the arch enemy of extraction. Hence some nations have necessarily resorted to low-pressure submachine guns, cam-extracting bolt action rifles, and heavier machine guns—especially the Communist nations.

All of which does not paint a pretty picture for hypermobile musketry—far from it. The new 8.50-pound automatic M14 rifle with cut-weight barrel saves 1.25 pounds over the 9.75-pound M1. The 23-pound M60 machine gun saves 13 pounds over the 36-pound M1919A6 Browning but is 3 pounds heavier than the 20-pound BAR M1918A2. However the M15 autorifle saves eight pounds over the BAR.

As I have suggested in several earlier writings, the lighter-barrel M14 (T44) with bipod can perform the autorifle mission substantially as well—and at some ten pounds with bipod cuts the old BAR weight in half. Among other factors making this possible are advanced "ball" powders and more rapid cooling of light barrels.

One single common rifle, with bipod attached for autorifle missions, would save a full two pounds plus production costs and assembly complications and would simplify supply and maintenance. Hence in my opinion the M15 (M14 with heavy barrel) is an unnecessary extravagance in mass and money.

Hypermobile musketry will demand a much higher order of combat accuracy than in the past. This will become a cold hard fact for future fighting, not a fetish of firearms fantasy. Hypermobility necessitates load lightening in terms of *hits* per pound, not *shots* per pound. Therefore combat accuracy means less pounds of lead for more effective hits—less shots fired per hit, less lead per shot, more hit certainty at realistic range, less costly logistic concession to random riflery.

Now there are many factors to be faced if hypermobile musketry is to be achieved. These are grouped as the weapon, the ammunition, the man. As man is the most limited, even when trained to the full for combat sharpshooting, we must do all we can with the weapon and the ammunition. But, except for highly trained snipers with telescopic sights, the musket and the man are pretty much limited to a maximum range of 4 to 5 football fields—400 to 500 yards. With a few exceptions you can't shoot what you can't hit and you can't hit what you can't see.

Without drawing complicated curves it appears that probable rifle targets are engaged chiefly at 100-200 yards, rarely beyond 300 yards, but occasionally at 400-500 yards. If hit probability at 100 yards is 1 hit per 3 rounds, it would be one hit per 9 rounds at 200 yards, per 15 rounds at 300 yards, per 30 rounds at 500 yards. Actual combat figures are far worse than this, yet my estimate assumes aimed semiautomatic fire with some upport to aid the operator. Unsupported offhand fire would require fully 4 times as many rounds per hit and would be limited to 200 yards.

THESE are combat, not Hollywood projections. In Korea we fired a quarter ton of rifle cartridges per enemy casualty, so something certainly must be done, and done quickly, for hypermobile musketry. The tempo of target training will have to be boosted.

Whatever its caliber the hypermobile

musket must weigh little more than the M1 carbine, no more than such light hunting rifles as the venerable Winchester Model 1894 .30-30 or Model 70 Featherweight .308—as close to six pounds as possible. Necessarily shoulder-fired, it could have a folding stock for convenient carrying.

One of the most useless and wasteful features is full-automatic fire from shoulder weapons, especially rifles. After the first shot there is just a lot of noise, few if any hits. Semiautomatic fire is far more efficient.

Tests which I directed 10 years ago with green troops showed that from the shoulder offhand at 25 meters, 10 shots could be effectively fired semiautomatic in from 2 to 4 seconds for an average rate of 200 shots a minute. Yet much time and money have been devoted to an attempted slowdown of full-automatic rates from a normal 600-800 to 200-300 shots a minute. Two pounds were added to the BAR M1918-A2 for this fruitless feature. The trigger finger can control the rate of discharge from one an hour to five a second. It has been said that such semiautomatic fire would tire the rifleman's trigger finger, though in two separate tests Johnson guns on semiautomatic fired 1,500 aimed rounds in 30 minutes, a rate of 50 a minute, plus reloading, with one unassisted operator. This meant a consumption of nearly 100 pounds of ammunition in half an hour. It would really be fatiguing to carry that load that long!

ABOUT ten years ago the writer made a series of demonstrations with a 12-pound bipod-mounted 20-shot shoulder weapon on semiautomatic versus trained personnel with tripod-mounted water-cooled machine guns and 25-pound full-automatic light machine guns. Ranges included paper practice 1,000-inch and combat targets at 100 to 700 meters. The semiautomatic system closely approached the heavy machine gun at 1,000 inches on paper targets and combat-course fire but was quite superior to the full-automatic light machine gun on both courses. The comparison was most obvious on shots plus time per combat hits up to 700 meters.

Full-automatic gadgets add complication to the mechanism of most conventional weapons. The past psychological advantage of burst blasts will be outweighed by the demand for conservation of cartridges in hypermobile musketry whether the enemy is scared of noise or not. Current cartridges per pound give some 18 to 20 rounds unclipped; future rounds may weigh 30 per pound.

Rifle zero is essential for cartridge-conserving combat hits. Just what is zero?

Take any rifle and adjust its sights so that a group of 5 to 10 shots center in the bull's-eye at 200 yards. When the shots strike the mark the rifle is on zero. This is usually accomplished from the prone position with forearm rest. Unless the rifle is on zero, aimed fire is useless.

The joker, however, is the tendency of many rifles to change zero under various conditions. Moreover the basic design of some semiautomatic and automatic weapons may aggravate zero change. Factors include barrel bedding in the stock, climate and day-night weather, heat from fast firing, breech design, sensitive sights, actual abuse.

If I had to choose between combat laboratory group accuracy or constant all-condition zero, I would take zero every time. The combat target is barely eighteen inches wide and rarely three feet high due to cover. So zero is a must for the hypermobile musket.

Feed and loading are major matters for consideration in hypermobile musketry. For over half a century there have been clips and box magazines. With twenty shots instead of ten, the new M14 rifle has the same loading features as a bolt-action rifle adopted fifty-seven years ago, the British short magazine Lee-Enfield. Optimum reliability of feed and ease of reloading in rifles has yet to be achieved, but this is a must for the musket of the millennium.

Reloading when the rifle is empty takes time and training. In an ideal hypermobile musket you should not have to reload for almost as many rounds as you can carry.

Above and beyond reloading is a belt system which would permit optional capacity and reliability—one in which the mechanism is dedicated to the feed. The marriage of a selectively endless feed with a minimum of mechanical monstrosity is the optimum objective.

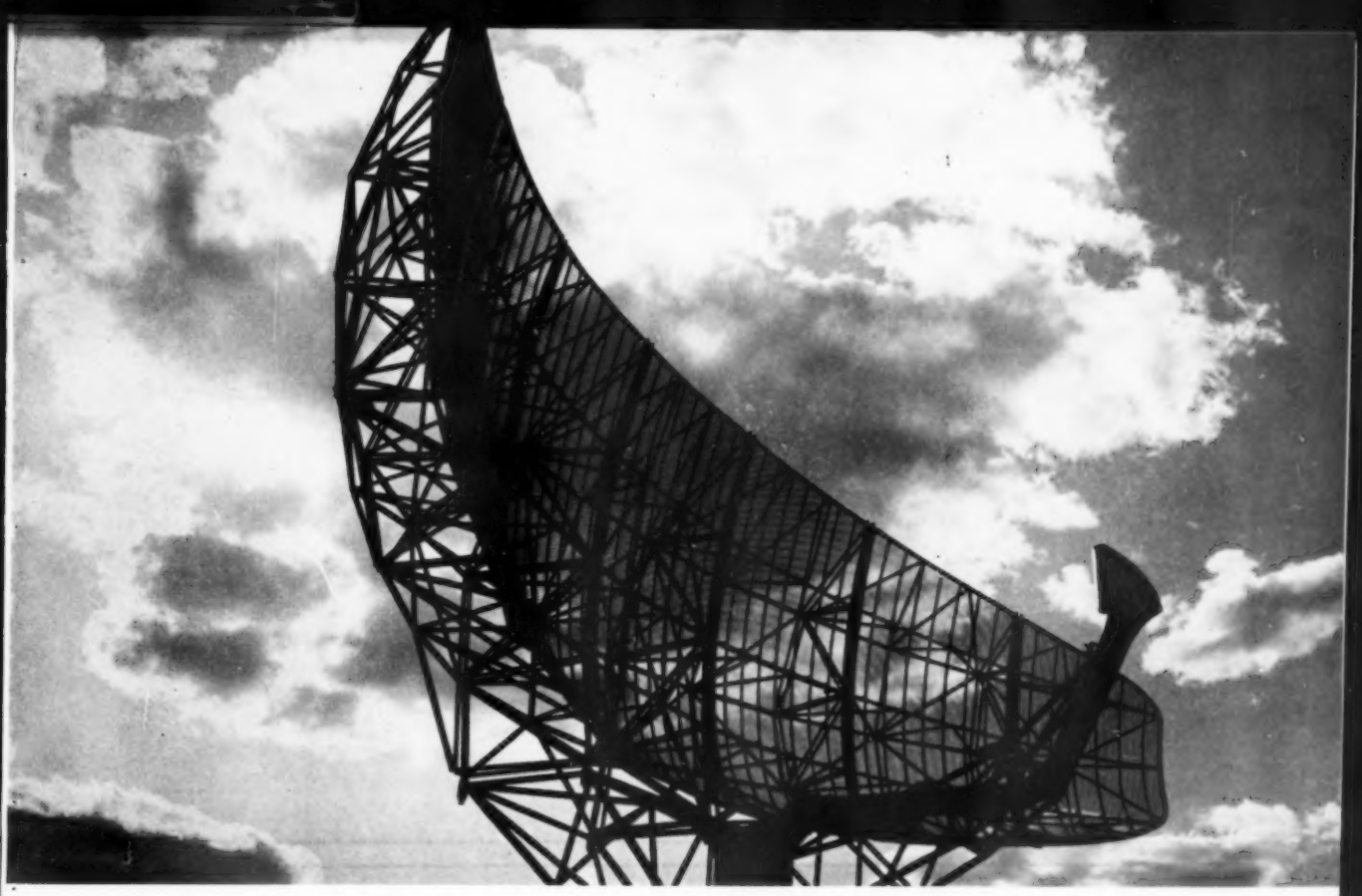
For snipers such as Tim Murphy who, in the Revolution at Saratoga, hit a redcoat general with a muzzle-loader at better than 300 yards, a .300 magnum triplesonic load with 180-grain boat-tail bullet would be feasible. However, the hypermobile hunter of human enemies cannot afford such a weight load or such a recoil. The solution must be found, not in maximum ballistics, but in average minimum power over most probable ranges to cause combat casualties.

At ranges up to 500 yards it is feasible to rely more on velocity of the bullet, less on its mass. If the major mission is effect beyond 500 yards, then the bullet must be much heavier. However, big bullets mean more weight per cartridge and more kick. Weight and heavy recoil are arch enemies of hypermobility.

THE density of the air at ground and even mountain levels contributes to a pronounced loss of terminal velocity in lighter weight bullets. For example a 48-grain caliber 220 bullet fired at 4,100 feet a second (Winchester Swift) loses 45 per cent of its velocity over 300 yards; a 180-grain caliber .30-06 bullet at 2,700 foot-seconds loses less than 20 per cent.

But the lighter bullet load shoots much flatter over 200 to 400 yards and is very lethal to boot. The lighter slug alone saves 130 grains per round, resulting in about 100 more bullets per pound of load, omitting common case and powder weight.

Hypermobile musketry must provide a weapon system of unconventional reliability and reduced weight built around feed, elimination of extraction and reciprocating breech motions. One combination pistol-subrifle will serve all personnel of the armed forces—air, sea, ground, and especially ground personnel performing other than rifle and machine-gun missions.



Small Business and Defense

Subcontracting assures continued production in event of emergency

John T. Williams

IT is a conviction as old as America itself that small business is essential to a sound economy and that its right to fair competition in a free market must be preserved. Less than four years ago, Congress reaffirmed and implemented this principle by creating a Small Business Administration, not only to provide technical and financial assistance but specifically to ensure the fair allotment of Government business. The policy of this agency was defined as follows:

"The essence of the American economic system of private enterprise is free competition. Only through full and free competition can free markets, free entry into business, and opportunities for the expression and growth of personal initiative and individual judgment be assured. The preservation and expansion of such competition is basic, not only to the economic well-being but to the security of this Nation. Such security and well-being cannot be realized unless the actual and potential capacity of small business is encouraged.

"It is the declared policy of the Congress that the Government should aid, counsel, assist, and protect, in so far as is possible, the interests of small business concerns in order to preserve free competitive enterprise, to ensure that a fair proportion of the total purchases and contracts for supplies and services for the Government be placed with small business enterprise, and to maintain and strengthen the over-all economy of the Nation."

For general purposes, a small business concern has been defined as "one which is independently owned and operated and not dominant in its field of operation." For procurement pur-

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poses, "any firm, including affiliates, which employs fewer than 500 persons is classified as small."

In defense industry in general, the new emphasis on small business procurement was timely and perhaps long overdue, but in certain defense activities, and particularly in the electronics industry, it merely confirmed a long-established policy. For in the electronics field, big business and small business had long been partners.

Operations at Raytheon Manufacturing Company, for example, exemplify this partnership. Raytheon's plants are located in the heart of the New England industrial area, the traditional home of Yankee ingenuity and high-precision craftsmanship. During World War II, as our company rapidly expanded from the manufacture of tubes and magnetic components to the production of entire electronic systems, hundreds of small local vendors were called in to aid in such projects as the SG/SO series radars.

WITHOUT the skills and facilities of these small businesses, the company's wartime production achievements would have been impossible. Raytheon has repeatedly stated that one of its greatest assets is the good will and coöperation of its colleagues in small business, and the company has never ceased to make full use of their capabilities.

Raytheon's written procurement policy with regard to small business may be summarized as follows: (1) To aid and encourage small business in every way possible consistent with our own needs; (2) To award orders to small business concerns whenever they are capable of fulfilling our requirements and their quality, prices, and delivery are competitive; (3) To maintain adequate records of our support of small business as requested by the services.

Small business procurement at Raytheon may be illustrated by considering a typical major project, the AN/TPS 1D radar. This is a high-power transportable air-search equipment for the early detection of enemy aircraft and other objects. It was designed for ground-base operation either in the field or at a fixed position. The equipment consists of six main units which may be stacked to form a supporting tower for the antenna as well as for the shelter tent provided

The AN/TPS-1D was manufactured for the Navy under 6 contracts totaling more than 1,000 sets. It was used not only by the Navy but by the Signal Corps, Marine Corps, and Air Force, and was furnished under the Mutual Defense Assistance Program to some of the member nations of NATO and SEATO. Under the Offshore Procurement Program, the same equipment was also produced by the company's European affiliate, Microlambda, for our allies. Probably no other radar equipment is so well-known throughout the world.

Production was continuous from 1951 to 1956—before and after the Small Business Act of 1953, yet the percentage of small business procurement was practically constant throughout.

The total sales value of the AN/TPS-1D over the 1951-1956 period was more than $48,000,000. Total purchases from vendors amounted to $27,859,555, or 57.8 per cent of the total sales value, of which $16,269,980, or 58.4 per cent, was placed with small business, with the remaining 41.6 per cent being awarded to large business.

Furthermore, a portion of the large business share was further subcontracted, with the result that approximately 12 per cent of additional purchases, or $1,390,749, eventually found its way to small business.

The geographical distribution of purchase orders is shown in the map on page 449. The large preponderance of New England vendors reflects not only the company's policy of doing business with local suppliers where possible but also the skills available in that area.

Procurement for a highly complex equipment such as the AN/TPS-1D is far more than a routine matter of writing purchase orders and specifications—it frequently involves continuing technical liaison with vendors, even to the extent of setting up production and quality-control procedures and training vendors' personnel.

Furthermore, it is our company's policy to incorporate the latest knowledge both from the engineering laboratories and from the field into the production line during the performance of the contracts. As a result, more than 2,000 engineering change orders were issued, many of which called for changes in vendors' production procedures and consequent reëducation of workers.

In view of this need for maintaining personal supervision of vendors' operations, it is noteworthy that all sections of the country benefited to some extent from the AN/TPS-1D contracts, as is evident from the map.

AN/TPS-1D production was considered so vital during the Korean conflict that our company was asked to establish a second source of manufacture. Accordingly, subcontracts for the production of complete AN/TPS-1D units, such as the indicator unit, were awarded to several small businesses experienced in the manufacture of high-grade electronic equipment. In order to bring these manufacturers to the point of delivering their first units, an immense amount of liaison was required. Some 15,000 drawings were forwarded; a total of 52 man-weeks were spent by the vendors' personnel at the company; and 140 man-weeks were spent by our personnel at the vendors' plants.

IN many cases, the training and guidance provided by the prime contractor not only enable the small vendor to fulfill the immediate purchase order but permanently equips him to perform more profitable operations than he was capable of handling before. Raytheon, for example, has trained many a precision craftsman working in an obsolescent field to apply his skill where it will fill an active need in today's technology. But this flow of instruction is by no means a one-way street: the prime contractor likewise benefits from the specialized knowledge and skills which small business is best able to provide.

The electronics industry includes thousands of businesses which, although small in size, represent the vanguard

in the development of new products and processes in their particular fields. Moreover, the rapidly changing nature of this industry places a high value on the flexibility which small business firms provide. Wherever defense contracts are concerned, this pooling of resources, talents, skills, and facilities is not elective but mandatory, since it so vitally affects our country's security.

Although this huge reservoir of advanced technology is potentially at the disposal of the entire electronics industry, it can be tapped with full efficiency only by the manufacturer who has built his vendor relationships over the years with fair dealing, care, and skill.

THE procurement history of the AN/TPS-1D is not an isolated instance but a typical example of our company's procurement policy. This is evidenced by the fact that in 1956 more than 55 per cent of the company's total purchases were made directly from small business.

When it is recognized that many items such as glass bulbs for tubes; specially treated metals such as oxygen-free copper, vacuum-cast molybdenum, steel alloys, aluminum, and nickel; motors, heavy production equipment, etc., must of necessity be purchased from large business because of their very nature, it will be seen that small business obtains the lion's share of all items that it is capable of supplying.

In fact, over-all procurement statistics at Raytheon reveal that small business obtains approximately 91 per cent of the company's procurement dollars in those fields where it can and does compete.

In spite of these facts and the experience of the electronics industry generally, it is apparent that many small businesses encounter difficulties in today's economy.

The efforts of organizations such as the Smaller Business Association of New England (SBANE) and the Strategic Industries Association (SIA) of Los Angeles, Calif., should be commended for their work in bringing their members' problems to the attention of Government and industry, both of which are making continuous efforts to improve the procurement and production of equipment for defense.

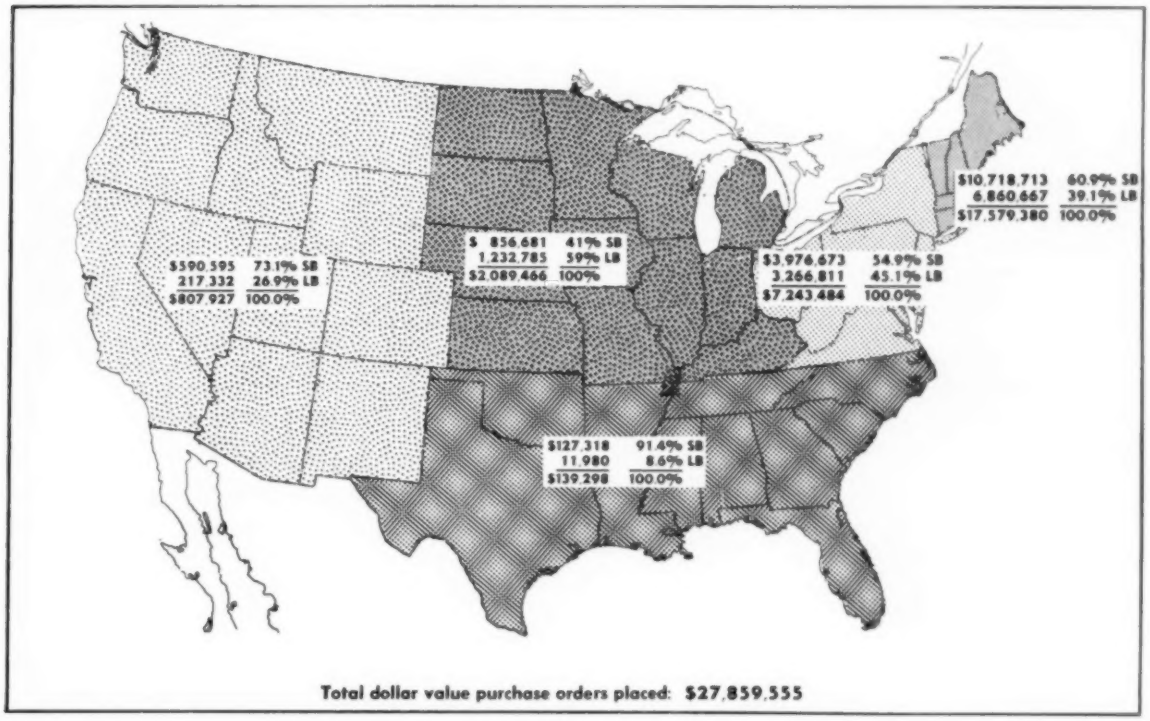
SIA's stand in opposition to a proposed congressional requirement for a mandatory fixed percentage of Government procurement from small business reflects an awareness of the problems of military procurement and recognizes that each business, large and small, must stand on its own feet economically, independent of potentially paternalistic national policies.

THAT both SBANE and SIA are aware of the problems of large business is evidenced by their opposition to the Government's renegotiation philosophy, particularly in relation to subcontracting.

While it is not our purpose here to discuss the Government's renegotiation policies, there appears to be a tendency at times to penalize the producer who subcontracts a substantial portion of his Government work. Obviously, this could cause a prime contractor to base his production planning on the premise that every possible phase of a contract must be performed in his own shop.

This type of thinking prevents maximum utilization of the Nation's industrial potential by failure to use the respective talents of both large and small business in complementary fashion.

Geographical distribution of dollar value of purchase orders for AN/TPS-1D radar placed with small and large business.



Whenever a manufacturer is the sole producer of strategic equipment there arises the problem of safeguarding production in the event of attack. The solution presently favored by the Department of Defense is the creation of a remotely located second source. To establish a second source in wartime doubtless would be feasible and effective, but to do so in a peacetime or cold-war economy is, for several reasons, an impracticable task.

First, the creation of the second source frequently entails a huge expenditure for duplicate facilities. Furthermore, the production volume of the prime source, and hence its production efficiency, is necessarily reduced. Past experience also indicates the likelihood of substantial added costs resulting from unsatisfactory performance on the part of the second source.

Other valid objections are raised by industry. In the absence of a hot war, industry feels itself entitled to full protection for its know-how, including not only its patents but also its technical information, much of which is not patentable.

Unless and until the Government is prepared to pay not only for the costs of performing a contract but also for the intrinsic values resulting from such performance, industry understandably will be reluctant to hand over gratis to a real or potential competitor the intangible but exceedingly valuable assets which constitute "know-how."

WHILE the development of the existing second-source program is thus severely limited, we believe that a practical program acceptable to all parties can be worked out. We suggest as a promising approach an extension and refinement of the plan used by our company with considerable success to supply additional AN/TPS-1D equipments. The fundamentals of such a plan are outlined below.

In many cases where a second source is considered vital, a production contract can be awarded to the original manufacturer with the written understanding that the equipment will be segregated into suitable components, each of which is to be manufactured and assembled by smaller subcontractors in areas sufficiently remote from the original source to afford reasonable protection in the event of enemy bombing. Many components can be handled on existing equipment and facilities with a minimum expenditure for duplicate equipment.

Final assembly, test, and Government inspection may in certain instances require the establishment of duplicate facilities; however, generally speaking, assembly and inspection facilities are far less costly than complete production facilities.

Since responsibility for over-all performance will rest with the original manufacturer and since his experience and know-how are most important in final assembly, the assembly and test areas could be operated by personnel of the original manufacturer.

In many cases, circumstances may require that final assembly be performed in the plant of a subcontractor under the observation or perhaps supervision of the prime source. In any event, development and refinement of this procurement plan should result in the following benefits:

1. The Government would benefit by: (a) Dealing with a single source whose technical competence in the manufacture of a specified article has already been established by performance on an earlier contract; (b) Reducing the costs of setting up complete duplicate facilities; (c) Reducing the hazards of nonperformance by the second source; (d) Reducing the over-all manpower requirements necessitated by complete duplicate facilities; (e) Utilizing efficient subcontracting, engineering, production, inspection, testing, and expediting organizations now existing in the organizations of prime producers, a portion of which the Government is already purchasing as part of the overhead rate negotiated in prime contracts; (f) Receiving greater coöperation from industry in the future development and manufacture of new products as the result of a freer atmosphere regarding unwarranted disclosure.

2. The prime contractor would benefit by: (a) Maintaining over-all control of the project; (b) Obtaining a greater return for his developing and manufacturing know-how; (c) Holding a competitive position in technical areas in which he may have excelled, because no one potential competitor would be in a position to be given *all* of the prime's know-how on a particular product; (d) Enjoying greater flexibility when negotiating with the Government for additional business as a prime; (e) Enjoying a better chance of survival as a business entity in the event of enemy bombing because he would not have the work concentrated in one plant.

3. Smaller concerns would benefit by: (a) Increased participation in the production of equipment for national defense; (b) Broader experience in the manufacture of military requirements without incurring the expense normally associated with prime contracts.

"Wherever defense contracts are concerned, pooling of resources, talents, skills, and facilities is not elective but mandatory."

SPACE does not permit further elaboration of this idea, but it readily will be seen that extensive opportunities exist for the wider dispersal of defense contract work while eliminating much of the expense of establishing a completely independent second source and much of the hazard of second-source performance.

Obviously, this plan is a compromise. It will not cover the procurement of *all* types of military equipment, and it will not satisfy industry in every instance, but it will afford the fundamental benefits of dual sources and provide a means for overcoming many of the difficulties which heretofore have seemed insurmountable.

Development and refinement of this plan should assist both the military and industry to achieve an improved nationwide production system adequate for our national security and with rewards to industry commensurate with its contributions.

First Precision Missile

In the bow and arrow man first found how to launch an aimed projectile to a distant target and still finds use today for the quiet and deadly penetrating power of this ancient weapon

G. V. Hurley

SINCE paleolithic times man has been interested in the development of missiles, aimed and accurate, for the purpose of inflicting death from a distance upon another man or an animal. A stone thrown by the arm was the first missile, and it was followed by the casting of a spear. The boomerang was a refined development of missiles cast by muscle energy, and very early in the history of man experiments were made in the mechanical propulsion of missiles. The sling, in many variations, made use of the principle of centrifugal force to develop into a dangerous weapon.

All these weapons shared one common defect. They could spray missiles into a defense perimeter of other men but they could not reach out, with certainty and accuracy, to destroy a distant target. It was the energy inherent in a strung bow that first made possible the launching of an aimed projectile that sped with precision and authority and pinned a definite target.

THE span of man's relationship with the bow, eight thousand years at least, and possibly ten thousand years or more, produced a grim and efficient missile that is still regarded with respect. The arrow is a purveyor of silent death. It has been estimated that five thousand men were killed by arrows in World War II. The twang of a bow accompanied numerous deaths of lone German sentries during the British Commando raids into Norway and elsewhere on the Continent. The bow was used in Asia throughout the war.

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The arrow is among the most dangerous of all missiles. Long after the introduction of gunpowder had substituted the bullet for the arrow, the feathered shaft remained the more formidable projectile, and the arrow still wings with great authority.

In range, the arrow is respected today, and with reason. When used as a weapon of war, the extreme range of the clothyard arrows of the longbow was close to three hundred yards. In the reign of Henry VIII, the usual military practice was conducted at two hundred meters—an eighth of a mile. The great composite bows of the Mongols and other tribes of Asiatic horse-archers could propel a 26-inch arrow for more than 800 yards, maximum range, and to an effective range that was well over 300 yards.

For many centuries no firearm could approach the effective ranges that were established by the bow.

The penetration achieved by ancient bowmen was remarkable. The Egyptian bows could send a reed-shafted arrow through four inches of brass. Chinese arrows could penetrate as many as seven thicknesses of the boiled hide armor of the period. The Mongols are credited with piercing European plate armor at 200 yards. The relatively weak American Plains Indian bows would send an arrow through the body of a buffalo, the arrowhead protruding a spans' breadth on the opposite side.

WHEN plate mail came into use, the English developed a bodkin point to ensure the holing of armor. It was the English practice to place a bit of wax on the bodkin point. A point so treated was less liable to glance from the metal surface. A 75-pound bow, using bodkin-point arrows, will penetrate steel plate to a depth of a quarter of an inch. In tests made on ancient armor, sparks flew when the bodkin point made contact. The armor was pierced and the arrow continued on to penetrate eight inches of wood.

Against horses, the damage inflicted by the clothyard arrow was greater than that inflicted by a bullet. The English bow could be relied upon to kill horses at ranges approaching 250 yards.

The frightful fatality of arrow wounds caused the French to protest bitterly (and without foundation), that the English poisoned their arrowheads. There is no record of the use of poison in battle by the English although they sometimes poisoned hunting arrows.

The tissue destruction resulting from an arrow wound is very great. It is, in fact, much more severe than that accomplished by any small-caliber, high-velocity, metal-jacketed bullet of any type permitted by the restrictions of the Geneva Convention. The laceration and internal hemorrhage caused by the arrow is frightful.

At maximum effective range the arrow is probably as deadly, or more deadly, than at point-blank range. Given sufficient remaining energy and velocity to achieve partial penetration, the arrow delivers enormous shock. At the end of its flight, an arrow still traveling with sufficient velocity to ensure penetration, tends to waver slightly in flight preparatory to its fall. Under such conditions, the arrowhead is subjected to vertical and lateral pressures as the shaft becomes unstable in flight. The resulting wound is large and irregular in course.

In cases where the arrow did not achieve complete penetration but remained in the body, the victim faced the ordeal of surgical extraction. In many cases, where the head was bound to the shaft with sinew, the body heat melted the fastening, leaving the detached arrowhead in the wound. This was often the case in our own wars in the west against Plains Indians.

Not the least horrifying effect of an arrow wound is the strong possibility of infection. An arrow offers a very large germ-bearing surface in head, shaft, and feathers. The dragging of this long projectile through a badly lacerated wound offers enormous possibilities of a fatal contamination.

THE fact that the arrow could be seen but not avoided often forced the troops who faced it into unreasoning panic. In this respect, the arrow had a psychological effect superior to that inflicted upon men under rifle fire. A man with an arrow in him, even though the wound was not fatal, or even dangerous, was seemingly unable, psychologically, to continue in action with the shaft in plain sight, protruding from any portion of his anatomy. Here again, a minor arrow wound, not in itself dangerous, resulted in shock when the missile was removed surgically.

The arrow cannot be compared with any high-velocity bullet, but it was inevitable that it should be compared with the round balls of the earlier muskets. Sir John Smith, writing in 1590, made the following comparison between the bow and the musket:

(1) Extreme nicety is required in taking sight with the musket; (2) Even at short range, the bullet is uncertain in flight; (3) Firearms are hot and dangerous after seven or eight rounds; (4) Powder is very deficient in quality; (5)When the muzzle is lowered, the bullet is prone to fall out of the barrel; (6) The musket is subject to erosive rust and to dangerous overcharging; (7) Weather conditions ruin powder and blow it from the pan; (8) A large body of musketeers is unable to resist a lesser body of cavalry; (9) Few are killed by musket fire after hours of battle.

Almost two centuries after Sir John, the controversy was still raging in England. In 1792, a match at Cumberland, at 100 yards, between musket and bow, produced a score of 16 arrows in the target while the musket was totaling 12 hits. When firearms first appeared in battle it was reckoned that 8,000 bowmen could handle 20,000 musketeers.

Defense against the arrow sets up a peculiar problem. It took the trial and error of many centuries to produce any solution. The most obvious protection, a metal shield of body armor, was the least effective deterrent to the arrow. The first armor, flexible chain mail with gambesons, was far more effective than the later plate mail. The wearer of chain mail was subject, however, to multiple wounds caused by splinters from the arrow shaft seeking intersices of the mail.

Reënforced chain mail, including banded mail, was developed about 1250 A.D. for protection against arrows and was effective. The arrow had to penetrate two flattened rings, reënforced by thick leather. Under this, a thick quilted gambeson greatly resisted penetration and reduced shock of impact. It was a very heavy outfit and excessively warm, but it greatly reduced the efficiency of the Saracen arrows during the Crusades.

Plate mail was one of the worst possible protections against arrows unless it was made strong enough to deny entry completely. Sheets of metal set up an inflexible and unyielding surface. An arrowhead of steel, traveling in excess of 100 miles an hour and helped by the driving force of a following shaft, was capable of holing all but the very best plate armor. The relatively thin metal plate offered just sufficient resistance to create a localized and highly concentrated shock center.

Usually the arrow was slowed sufficiently by the plate to ensure retention of the arrow in the body after deep penetration was accomplished.

The field experience against the Saracens taught the Crusaders that a better defense than any type of armor was a thick quilting of padded cotton that absorbed much of the original shock and strongly resisted penetration. The quilted surcoats of Richard's crossbowmen stopped the Saracen arrows even when not backed with armor.

POSSIBLY the best defense against the arrow was the method devised by the Mongols of accepting the casualty and minimizing the effect. To accomplish this Mongol troops went into battle relatively unprotected but wearing thick inner clothing of raw silk. It was in no sense a substitute for armor as it had no resistance to penetration.

The value of silk lay in the fact that the arrowhead would not usually cut through the fabric. As the result, the silk was carried into the wound, permitting relatively easy extraction of the arrowhead. By gently pulling on the enclosing silk, the arrowhead was gradually withdrawn from the wound. The casualty was thus spared enlargement of the wound by surgery and was given good protection from infection.

The head and shaft of an arrow, producing a missile of great sectional depth, is effectively used in modern bullet design where great penetration is required. The 6.5-mm. Mannlicher bullet, small in caliber and long in form, is a modern derivative of the excellent design inherent in the arrow's long, narrow shape.

Mobility Unlimited

Water-based aircraft promise a revolution in modern military logistics

Maj. Thomas J. McDonald

THREE critical break-throughs in the technology of transportation promise a revolution in military logistics. Obscured in the popular mind by atomics, electronics, and guided missiles, the collective influence of these advances may be as significant in the pattern of tomorrow's war as the wonder weapons.

One break-through has occurred in the design of water-based aircraft; the second in the development of medium-size cargo airplanes with short, versatile take-off and landing capabilities; the third in surface transportation—the remarkable large-wheeled vehicles evolved for the commercial earth-moving and lumber industries.

Logistics planners feel these three developments can be integrated into a concept for deployment and support of major forces which offers promise of victory in either "all-out" or "limited" war.

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Mobility has primary importance in "nuclear dispersion." It is equally essential in countering "limited" incursions by a calculating enemy in Korea, Indochina, Viet Nam, or the unknown names of tomorrow's headlines. These developments make a new order of mobility feasible. They provide the means for creating a flexible system of overseas logistics operating normally along lines heretofore reserved for expedients like the Red Ball Express or the Berlin Airlift.

The impact of water-based aircraft on logistics stems from the necessity of providing heavy-duty runways several miles long plus elaborate facilities for land-based bomber, cargo, and commercial jet fleets. Aside from locating sites, a problem plaguing expansion of commercial jet service today, many engineer battalion-weeks of effort are required for construction. Such delay is prohibitive for major force deployment in the peripheral actions we have been encountering since World War II.

Not only are permanent facilities hard to come by in primitive areas but where they do exist, size and fixed locations make them vulnerable focal points for enemy action, limiting the utility of land-based troop and cargo carriers for combat operations.

Water basing permits the use of large seaplanes for priority intercontinental cargo movement—jets capable of flying thousands of miles at the speed of sound. Such craft are capable of

landing and taking off from lakes, inland waterways, and coastal waters without extensive construction effort. They require neither airfields nor ports. Discharge and loading can be accomplished rapidly. Base areas themselves can be shifted, constantly confounding enemy interdictory efforts. The great speed and large cargo capacity provided can result in substantial reductions in the size and number of farshore logistical facilities.

Jet aircraft configuration, unlike that of propeller-driven airplanes, lends itself to operation on the surface of the ocean almost as readily as in the air. The elimination of propellers and introduction of "speed-of-sound streamlining," alloy improvements which reduce hull corrosion, improved methods of berthing and discharge, coupled with elimination of landing gear (up to twelve per cent of a landplane's weight), point up jet seaplanes as the long-range combat cargo carriers of tomorrow.

The largest part of the earth's surface consists of water. It is available in reasonable proximity to even the most arid areas. Shallow draft plus the ability to land and take off in moderate surface turbulence gives water-based transport an unparalleled basing advantage.

THE advent of nuclear reactors as aircraft power plants will herald the possibility of giant seaplanes capable of carrying hundreds of tons or thousands of troops over practically limitless distances. A properly trained tactical ground force could be committed in a fleet of such craft in days—even hours—instead of the months required for deployment by traditional means. Such a force committed in the first hours of the Korean emergency might have brought the issue to early resolution.

The logistical implications of water-based lift are that critical and "unpredictable" forms of cargo, such as plasma, repair parts, and replacement equipment, can be moved with jet speed on a selective basis directly from the zone of the interior to a combat theater, eliminating mountainous stacks of supplies in ports and depots which are necessarily a part of less responsive systems.

The jets can augment (not replace) surface shipping. The great bulk of tonnage moving overseas to support a combat force will still move by ship because the preponderance of combat requirements are ammunition, fuel, and food—heavy, predictable, commodities in which a comparatively small number of items constitute the bulk of traffic.

Air lift for these items is normally unnecessary since the consumption rate for a major force can be predicted accurately, but the fact that such a lift exists and can be used from time to time in meeting sudden emergency requirements can permit major reductions in the reserve level of these supplies overseas.

The jets will be able to move personnel, mail, plasma, critical supplies, or even the heaviest items (most of the impedimenta of the Pentomic force must be designed for air-lift). Myriad thousands of repair parts and other varied, highly unpredictable items will be their principal cargo.

INSTEAD of attempting to store large quantities of sporadically required supplies overseas, single-line electronic requisitions can be transmitted from combat zone to U. S. depots for rapid air fulfillment. Shipments will be specifically consigned, in many cases to the requesting unit.

During World War II, over 21 million tons of logistical support for U. S. forces moved through the pandemonium of European ports. Unclassified masses of food, fuel, ammunition, and miscellaneous stocks challenged the ingenuity of shippers, port authorities, and supply personnel. Around-the-clock bulk handling of tonnage—classification, storing, transfer, and issue—converted these 21 million tons to hundreds of millions through countless rehandlings from port to front.

By April of 1945 over one quarter of the 4 million U. S. personnel in General Eisenhower's command were in the communications zone, and a large part of the others were more closely associated with the sprawling administrative support system than with the fighting line.

Atomic bombs rendered this system obsolescent. The atomic missile makes it obsolete. The chief protection that can be afforded such operations is distance, dispersion, and mobility.

Instead of a few massive port-depot complexes such as Cherbourg and Pu-

The mammoth vehicle below is shown climbing a 40-degree slope carrying two tractors, its big wheels giving it a superior payload-to-gross weight ratio.

Even before propellers stop turning, a vehicle bat mission for the 101st Airborne Division

san, support for the Pentomic ground force will enter the theater by seaplane and ocean shipping through numerous widely scattered and mobile bases. These rendezvous points will be shifted as dictated by conditions, probably often due to the range and increasing accuracy of guided missiles.

Unlike permanent port facilities which are dependent on railroads, old-fashioned highway truck fleets, and conventional aircraft, priority support entering the theater will be shifted rapidly by high-lift cargo airplanes which constitute an important connecting link between beaches of entry and the combat area.

NEW adjectives have been coined to describe the capabilities of these aircraft to include "Stol" (abbreviation for "Short take-off and landing"); "high lift," indicating an ability to get in and out of unusually short strips; and "pantobased," which means that such planes are equipped for landing or take-off on rough, unprepared fields, sand, ice, or water.

Forgotten studies conducted for the U. S. and British Navies before World War II have been dusted off as the springboards for a new line of development into ways of getting fixed-wing aircraft up and down with a minimum of runway.

The experimental "flying platform," which has received much recent publicity, demonstrates one of the techniques aircraft designers look to in achieving their objectives. This "ducted fan," while promising, is only one of several likely means. Others include the vectored wing (the slipstream from the propeller is diverted over the wing surfaces in a manner to induce lift), and boundary layer control in which forced air streams are used to enhance the lift capabilities of wing surfaces.

Breguet of France has successfully landed and taken off a cargo airplane carrying approximately 2 tons on a field 200 feet in length. Fairchild and other companies are working on a variety of improved fixed-wing craft which give promise of landing 8 tons on pasturelike fields 500 feet long.

Extensive airfield construction requirements will thereby shrink in forward areas permitting terminal points for fleets of 8- and 10-ton, high-lift aircraft to be shifted at will. This is an absolute necessity as the threat of tactical missiles increases, for fixed sites, once located, are certain to become targets for attack.

Two hundred tons, the contents of four jet seaplanes each carrying fifty tons of cargo (which had been flown from the U. S. in a few hours), could be moved from a beach entry area to a division three hundred miles inland in only five high-lift aircraft if they each made four round trips. Two hundred tons a day would pretty well cover unpredictable supply requirements of a division, and that same lift could be used for evacuation.

It is hard to determine which of many techniques will eventually win out in the push toward improved short-take-off airplanes.

The prototype of this kind of aircraft is in Air Force troop-carrier use today as the Fairchild C-123. It can land and take off with 8 tons of cargo from any reasonably clear and level patch of ground 700 feet long. With modern navigational equipment it has the capability of delivering combat cargoes in weather which a few years ago would have grounded all flights.

Medium-sized cargo craft of this type, capable of flying hundreds of miles at two to three hundred miles an hour, constitute only a fraction of the maintenance problem associated with helicopters.

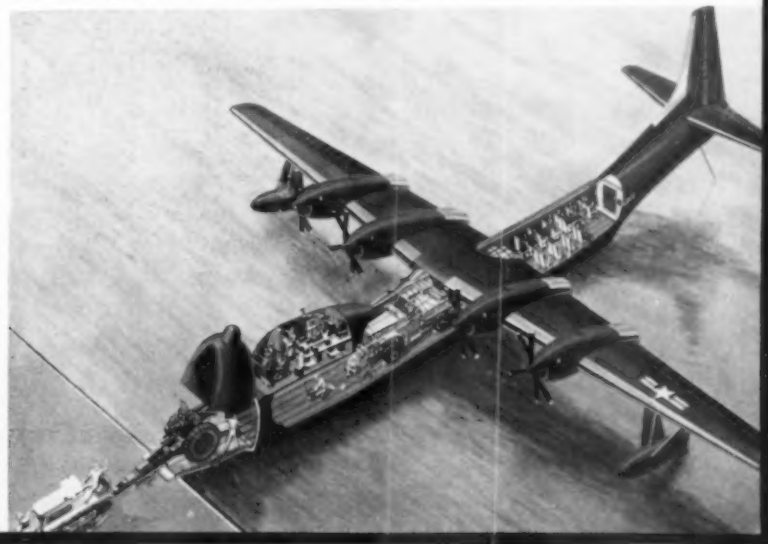
The piloted combat aircraft is slated for gradual replacement by missiles, but the piloted cargo aircraft has an indefinite future on tomorrow's battlefield. It may not carry the bulk of tonnage from the beaches to the front but it will carry critical loads, red-hot, "unpredictable" shipments direct by air from the rear to mobile distribution detachments serving artillery battalions and battle groups.

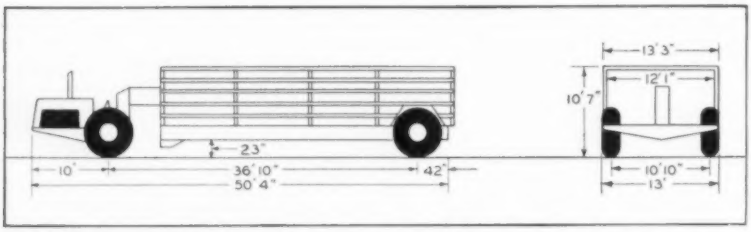
The rear-area beaches located as far as possible from enemy bases will be closer in time to the combat line than division supply points in World War II.

ONLY recently has the subject of land locomotion, improved cross-country manueverability, and associated subjects been the object of a major research effort, but the silhouette of the military truck, rigidly the same since World

brought by a C-123 is on its way to a com- during recent assault aircraft maneuvers.

Cutaway drawing of the Convair Tradewinds illustrates the tremendous load the "flying LST" is capable of handling for long-range deployment.





Scale drawing of a big-wheeled military-type vehicle capable of carrying ammunition, fuel, food, and equipment across country and through deep streams.

War I, finally may begin to change. The surface member of the theater transportation team is well along the developmental path not far behind its high-lift aircraft partner. The commercial prototype of such a vehicle is the ubiquitous big-wheeled earth-mover bouncing powerfully along on every major highway construction job across the United States.

A prime factor in the superhighway program, a key piece of equipment in construction, lumbering, and other special fields, the big-wheeled truck looks like a solution to the surface logistics problem.

THE civilian earth-moving and lumbering vehicle is a giant that moves along over rough terrain with amazing agility, possessing a pay-load-to-gross-weight ratio which is far more favorable than that of conventional highway vehicles of the modern fleet. Up to half the total loaded weight is cargo as opposed to twenty-five to thirty-five per cent in ordinary trucks.

Giant tires (up to 10 feet in diameter on a 35-ton vehicle) take up the bounce in rough country, eliminating the need for springs or complicated suspension systems.

Earth-moving and logging vehicles have been compared to conventional military vehicles in cross-country mobility. They have been able to go through the "rock gardens," over the "hogbacks," through the artificial swamps of the proving grounds. The remarkable capacity of the big wheels with their low ground pressures gives these vehicles a capability for movement through terrain that stops almost any other type vehicle.

To the extent that a bicycle outperforms a pair of roller skates crossing an open field, the big-wheeled vehicles, with greater ground clearance and better vertical obstacle-crossing capabilities, move heavier cargoes than small-wheeled types. The large tires have less rolling resistance, wear cooler and longer, and are less susceptible to puncture.

Another feature of the big-wheeled vehicle is powered-king-pin steer. Electric or hydraulic power is applied at the king-pin connection between tractor and trailer, providing the capability of making a 180-degree turn in a roadway less wide than the length of the vehicle. By ensuring that steering does not compromise traction, this element combines with the large wheel diameters to assure movement in bogs, sand, or snow. It permits "duck walking" and creeping.

Such vehicles carrying fifty tons of predictable ammunition or fuel could make a scheduled, unhurried haul from beach of entry to battle area unrestricted to existing road nets, unhampered by wreckage-strewn roadways.

The earth-moving type vehicle can be given another vitally important capability for military purposes. Proponents contend that the boxlike nature of its design, with weight evenly distributed, could be given an amphibious capability sufficient to ensure crossing inland waterways under load whether bridges have been atomized or destroyed by guerrillas.

A fleet of these vehicles operating with a new order of cross-country freedom could take the place of railroads and ordinary highway systems in carrying the bulk of support forward.

MOVING at thirty miles an hour, a fleet of 6 fifty-ton big-wheelers could deliver 300 tons of food, fuel, and ammunition to a division. Maintenance and fuel requirements for these vehicles could be considerably less than for present-day truck fleets.

The air-ground team of short take-off pantobased aircraft and big-wheeled vehicles will not be limited to fixed schedules or definite routes for movement. Their terminal points will change constantly. They will be far less vulnerable to enemy attack than trains, ports, bridges and tunnels, or commercial-type trucks.

It will be more difficult for enemy air missiles or guerrillas to destroy either big-wheeled vehicles or high-lift aircraft than to inflict serious and usually longer lasting interruptions on a dock, railroad, or pipeline.

The costs of developing and field-testing such a fleet now may be more than returned by reductions in the number of logistical echelons needed to support an overseas combat force. Personnel savings stemming from reductions in the familiar multiple echelons of depots can be applied toward the maintenance and support requirements of the flexible system.

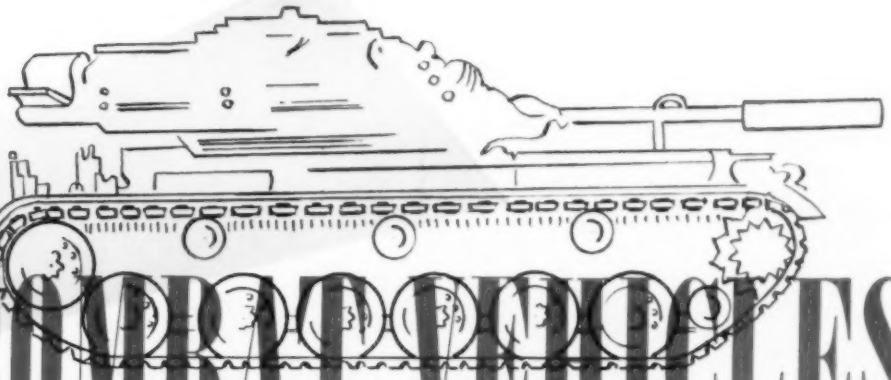
ATTENTION can be devoted to moving support selectively through the "pipeline" in a manner to minimize the number and size of installations. By keeping facilities small and support moving, over-all supply quantities can be reduced. Support can be where it is needed on time rather than heaped hundreds of miles behind, useless to the fighting elements.

A small logistical command charged with support of a single corps could handle logistics from beaches of entry to the front across hundreds of miles using big-wheelers and high-lift aircraft.

In commenting on his World War II experiences, Field Marshal Montgomery reflected the views of most major commanders. He said that four fifths of his over-all problems had been logistical in nature.

The real answer to logistical needs when ports, highways, airfields, rail lines, pipelines, tunnels, and bridges are totally lacking in an undeveloped area, when long-range missiles can single out fixed installations for instantaneous destruction, is a system which functions without reliance on these facilities, and such a system is now within the realm of practicability.

AMERICAN ARMAMENT, II



COMBAT VEHICLES

OF THE U.S. ARMED FORCES

An outline of the vehicles — both operational and developmental — of the Army, and Marine Corps of the United States designed by engineers and scientists of the armed forces, educational institutions, and industrial organizations and produced by American industry for the national defense of the United States.

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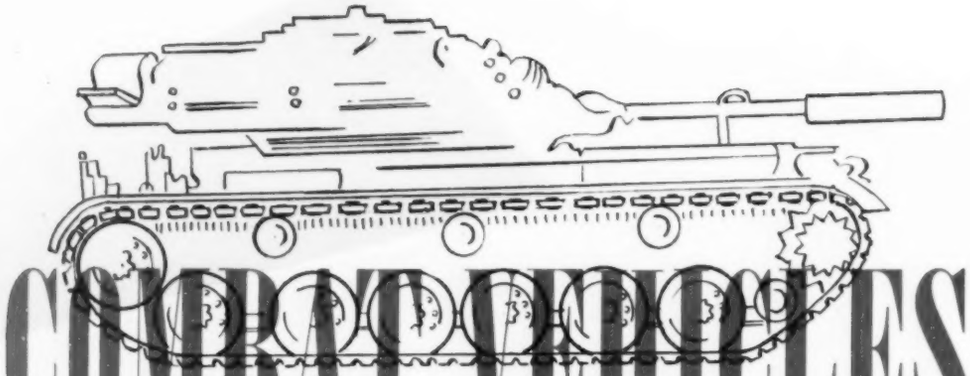
ORDNANCE

Bimonthly Journal of the American Ordnance Association

Washington 6, D. C.



COMBAT VEHICLES

OF THE U.S. ARMED FORCES

The vehicles shown in this presentation are those operational and developmental types employed by the United States Army and Marine Corps. They are vehicles that either have an offensive capability, are armored, or are able to operate through water or across country under combat conditions. Other types of combat vehicles are under development and will be presented when officially announced. Most of the accompanying pictures are from Army photos. Military trucks will be treated here in a later issue.

General-Purpose Vehicles ■ Tanks ■ Personnel Carriers ■
Self-Propelled Artillery ■ Recovery & Cargo Vehicles □

GENERAL-PURPOSE VEHICLES

MECHANICAL MULE.—This vehicle, shown at the left armed with a 106-mm. recoilless rifle, is a versatile conveyance and can carry weapons, personnel, or supplies far forward in the combat zone. Air-droppable, it has 4-wheel drive. Prime manufacturer, Willys Motors, Incorporated.

JEEP.—The ubiquitous ¼-ton, 4x4 truck has proved its ability and versatility in combat in World War II and in Korea. As shown at the right armed with the 106-mm. recoilless rifle, it is used as a battalion antitank weapon called the BAT. Prime manufacturer, Willys Motors, Incorporated.

TANKS

LIGHT TANK T92.—This reconnaissance-ty
with a 76-mm. high-velocity gun and cal. .30 an
guns in side turrets. Developed by Aircraft Ar
vehicle weighs 18 tons and is designed f

PERSONNEL CARRIERS

INFANTRY VEHICLE M75.—Armament, cal
Speed, 44.5 m.p.h. Cruising range, 115 miles. Cros
wide. Climbs obstacle 24 inches high. Weight,
Armored. Prime manufacturer, International H

SELF-PROPELLED ARTILLERY

106-MM. M50 (ONTOS).—Armament, six
recoilless rifles, four spotting rifles, one cal
chine gun. Weight, 8.5 tons. Used by Marin
manufacturer, Allis-Chalmers Manufacturing

nce-type tank is armed
.30 and cal. .50 machine
raft Armament, Inc., the
gned for air transport.

LIGHT TANK M41A1.—Armament, 76-mm. gun, cal. .30 and .50 machine guns. Speed, 46 m.p.h. Cruising range, 100 miles. Crosses trench 72 inches wide. Climbs obstacle 28 inches high. Weight, 26 tons. Crew, 4. Prime manufacturer, Cadillac Division, GMC.

MEDIUM TANK M47.—Armament, 90-mm. gun, two cal. .30 machine guns. Speed, 37 m.p.h. Range, 80 miles. Crosses trench 78 inches wide. Climbs obstacle 36 inches high. Weight, 46 tons. Crew, 5. Prime manufacturers were American Locomotive Co. and Detroit Arsenal.

MEDIUM TANK M48.—Armament,
chine guns. Speed, 30 m.p.h. Range,
inches wide. Climbs obstacle 36 inch
4. Manufacturers, American Locom

ent, cal. .50 machine gun.
s. Crosses trench 66 inches
Weight, 18 tons. Crew, 1.
onal Harvester Company.

INFANTRY VEHICLE M59.—Armament, cal. .50 machine gun. Speed, 32 m.p.h. Range, 120 miles. Crosses trench 66 inches wide. Climbs obstacle 18 inches high. Weight, 19 tons. Crew, 1. Armored and amphibious. Prime manufacturer, Food Machinery.

LANDING VEHICLE LVTP5.—Armament, machine guns. Speed, 27 m.p.h. on land, 7 m.p.h. in water. Land range, 180 miles. Crosses trench 102 inches wide. Climbs obstacle 36 inches high. Weight, 35 tons. Armored and amphibious. Used by U. S. Marine Corps.

LANDING VEHICLE LVTH6.—
full-tracked Marine vehicle with th
but mounting a 105-mm. howitzer.
hicles is the Ingersoll Kalamazoo

LERY

nt, six 106-mm.
one cal. .30 ma-
Marines. Prime
turing Company.

40-MM. M42A1.—Armament, dual 40-mm. guns, cal. .30 machine gun. Speed, 45 m.p.h. Cruising range, 100 miles. Crosses trench 72 inches wide. Climbs obstacle 28 inches high. Weight, 25 tons. Crew, 6. Manufacturers, ACF, and Cadillac Division, General Motors Corp.

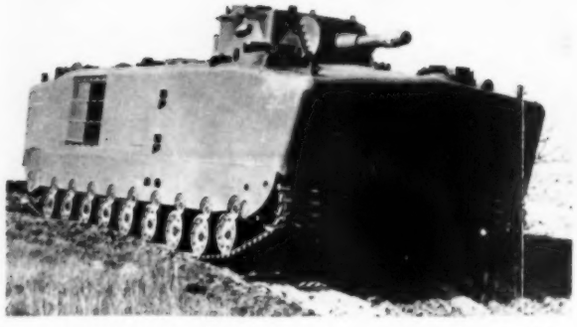
90-MM. M56 (SPAT).—Armament, 90-mm. gun. Speed, 28 m.p.h. Cruising range, 140 miles. Has capability of crossing a trench 48 inches wide and of climbing a vertical obstacle 30 inches high. Weight of the vehicle is 7.5 tons, and it carries a crew of 3. It is an unarmored antitank weapon designed for air transport and air drop. Prime manufacturer, Cadillac Motor Car Division, General Motors Corporation.

MEDIUM TANK M47.—Armament, 90-mm. gun, two cal. .30 machine guns. Speed, 37 m.p.h. Range, 80 miles. Crosses trench 78 inches wide. Climbs obstacle 36 inches high. Weight, 46 tons. Crew, 5. Prime manufacturers were American Locomotive Co. and Detroit Arsenal.

MEDIUM TANK M48.—Armament, 90-mm. gun, cal. .30 and .50 machine guns. Speed, 30 m.p.h. Range, 195 miles. Crosses trench 105 inches wide. Climbs obstacle 36 inches high. Weight, 49 tons. Crew, 4. Manufacturers, American Locomotive, Chrysler, GMC, Ford.

HEAVY TANK M103.—Armament, 120-mm. gun, cal. .30 and .50 machine guns. Speed, 21 m.p.h. Cruising range, 80 miles. Crosses trench 90 inches wide. Climbs obstacle 36 inches high. Weight, 59 tons. Crew, 5. Prime manufacturer, Chrysler Corporation.

LANDING VEHICLE LVTP5.—Armament, machine guns. Speed, 27 m.p.h. on land, 7 m.p.h. in water. Land range, 180 miles. Crosses trench 102 inches wide. Climbs obstacle 36 inches high. Weight, 35 tons. Armored and amphibious. Used by U. S. Marine Corps.



LANDING VEHICLE LVTH6.—This is an armored, amphibious, full-tracked Marine vehicle with the same basic hull as the LVTP5 but mounting a 105-mm. howitzer. The design agent for both vehicles is the Ingersoll Kalamazoo Division of Borg-Warner Corp.

AMPHIBIOUS CARRIER M76 (OTTER).—For cargo or personnel. Armament, cal. .50 machine gun. Speed, 28 m.p.h. Range, 200 miles. Crosses trench 60 inches wide. Climbs obstacle 18 inches high. Weight, 4 tons. Prime manufacturer, Pontiac Division, GMC.

M, M56 (SPAT).—Armament, 90-mm. gun. Speed, 28 m.p.h. Cruising range, 140 miles. Has capabilf crossing a trench 48 inches wide and of climbing a vertical obstacle 30 inches high. Weight of ehicle is 7.5 tons, and it carries a crew of 3. It is an unarmored antitank weapon designed for air ort and air drop. Prime manufacturer, Cadillac Motor Car Division, General Motors Corporation.

105-MM. M52.—Armament, 105-mm. howitzer, cal. .50 machine gun. Speed, 45 m.p.h. Cruising range 91 miles. Crosses trench 72 inches wide. Climbs obstacle 30 inches high. Weight, 25 tons. Crew, 5. Turret traverse, 120 degrees. Prime manufacturer, ACF.

155-MM. M53.—Armament, 1
gun. Speed, 31 m.p.h. Range,
inches wide. Climbs obstacle 4
Crew, 6. Prime manufacturer, Pa

RECOVERY & CARGO VEHICLES

RECOVERY VEHICLE M74.—Armament, cal. .30 and .50 machine guns. Speed, 21 m.p.h. Cruising range, 100 miles. Crosses trench 90 inches wide. Climbs obstacle 24 inches high. Weight, 45 tons. Crew, 4. Prime manufacturer, Bowen-McLaughlin-York, Inc.

RECOVERY VEHICLE M51.—Armament, cal. .50 machine gun. Speed, 30 m.p.h. Cruising range, 150 miles. Crosses trench 96 inches wide. Climbs obstacle 36 inches high. Weight, 56 tons. Crew, 4. For recovering tanks and other heavy vehicles. Prime manufacturer, Detroit Arsenal.

CARGO TRACTOR M8A1.—Armament, cal. .50 machine gun. Speed, 41 m.p.h. Cruising range, 180 miles. Crosses trench 84 inches wide. Climbs obstacle 30 inches high. Weight, 22 tons. Crew, 4. Equipped with bulldozer. Prime manufacturer, Allis-Chalmers Manufacturing Co.

AMPHIBIOUS TRUCK XM147 (SUPERDUCK).—This 6x6 vehicle can carry 4 tons of payload over land or from ship to shore through heavy surf. Speed, 50 m.p.h. on land, 7 m.p.h. in water. Land cruising range, 500 miles. Weight, 9 tons. Prime manufacturer, General Motors Corp.

ent, 155-mm. gun, cal. .50 machine Range, 170 miles. Crosses trench 95 tacle 42 inches high. Weight, 47 tons. rer, Pacific Car and Foundry Company.

155-MM. M44.—Armament, 155-mm. howitzer, cal. .50 machine gun. Speed, 35 m.p.h. Range, 169 miles. Crosses trench 72 inches wide. Climbs obstacle 30 inches high. Weight, 31 tons. Crew, 5. Prime manufacturer, Massey-Harris-Ferguson, Inc.

8-INCH M55.—Armament, 8-inch howitzer, cal. .50 machine gun. Speed, 30 m.p.h. Cruising range, 150 miles. Crosses trench 95 inches wide. Climbs obstacle 42 inches high. Weight, 38 tons. Crew, 6. Prime manufacturer, Pacific Car and Foundry Company.

The Cordiner Proposals

The Defense Advisory Committee on Professional and Technical Compensation urges the application of pay and job incentives to the armed forces as the key to a sound national defense

William V. Kennedy

OF all the problems confronting the American people in this age of awesome nuclear power, none looms larger than the serious shortage of skilled technicians that has developed within *all* our armed forces —Army, Navy, and Air.

Service-trained electronics engineers, jet-engine and tracked-vehicle mechanics, armament technicians, and radio and radar repairmen have been leaving the service in droves at the end of their initial enlistment or, in the case of officers, at the end of their obligated tour of duty.

Each of them takes with him a large investment in public time and funds in the lengthy and expensive training he has received. Behind him he leaves the equally expansive and time-consuming task of training replacements.

Out of it all, the Nation finds itself "short-changed," unable to realize the full potential of its ships, aircraft, and fighting organizations simply because it cannot manage to attract and retain sufficient numbers of high-type, highly skilled manpower.

SINCE the spring of 1956 a Defense Advisory Committee on Professional and Technical Compensation headed by Ralph J. Cordiner, president of General Electric Company, has been grappling with the task of finding a solution.

Following an exhaustive field study both in the United States and overseas, the Cordiner Committee recommended, in March 1957, a program that its chairman predicted could effect "savings and gains up to five billion dollars a year . . . within five years or less." Of perhaps even greater importance, Mr. Cordiner predicted that the program could "increase the combat effectiveness of the armed forces by about fifteen per cent at present costs."

Mr. Kennedy is an officer of the 104th Armored Cavalry Regiment, Pennsylvania National Guard. He is the former executive editor of the Pennsylvania Guardsman.

It would seem that a program promising advantages of such magnitude would gain the immediate and careful attention of a cost-conscious nation. Not only has such interest failed to materialize, but the Cordiner recommendations are in grave danger of being watered down to the point of impotency or allowed to molder away, victims of overcaution and expediency both in the budgetary offices and in Congress.

It behooves those who are aware of the grave nature of the shortage in skilled military manpower to examine the Cordiner proposals closely. If they are found to have merit, and this writer believes they have great merit, then it is the duty of every informed American to press for their adoption before both Congress and the public.

The Cordiner Committee expects to achieve the predicted monetary savings and increase in combat potential through application to the military of the economic incentives upon which American industry has operated since its infancy.

"In time of peace," the Cordiner report states, "patriotism alone is not a sufficient motivation for a career in the armed forces. The members of the military establishment must receive sufficient compensation to enable them to establish a standard of living which will allow them to discharge their responsibilities to their country *and* to their families simultaneously. The compensation system of the armed forces should be related to the state of the national economy."

STUDIES conducted for the committee by McKinsey & Company, a management consultant firm, showed that in almost every occupation from truck driver to radio-radar system technician, the monetary rewards of civilian employment and the opportunities for advancement far outstrip those offered by the services.

The committee also found that "fringe benefits (post exchange, medical and housing savings, and privileges) no longer favor the enlisted man over his civilian counterpart, except for the 20-year retirement option."

To this must be added the hardships imposed on the military family

by the continual alert, the strenuous operating schedule, and the frequent and prolonged separations of the Cold War era.

The "fogey pay system," dubbed the "Methuselah System" by the committee, by which a man receives periodic pay increases based solely on longevity, further complicates the problem by making it possible for a subordinate to be paid considerably more than his supervisor.

The Cordiner Committee's solution begins by ruling out any "across-the-board" pay increase. Instead, it envisages a complete overhaul of the military pay system, discarding the longevity system and substituting for it one "designed to encourage meritorious performance and advancement rather than just survival for a lengthy period of time."

As regards officer pay, the Cordiner Committee found that junior officers "were not particularly dissatisfied with their current pay, but they were decidedly outspoken regarding the compensation they could expect as senior officers."

In short, the officer has but to look around him to see that his commander has little more to show for a lifetime of ever-increasing responsibilities than the most junior of his subordinates.

To correct this, the Cordiner Committee recommends an officer pay scale ranging from a little over $300 a month for an unmarried second lieutenant to approximately $2,200 a month for a 4-star general. The figures include allowances for rations and quarters.

THE second lieutenant's pay would be about as it is at present. The proposed pay for a 4-star general represents an increase of nearly $900 a month over the present rate. About a third of this increase would consist of an "active-duty pay supplemental" which would be paid only when the officer was on active duty for a period of over thirty days. The supplemental would not be considered in computing retirement pay.

In the event this pay scale is adopted, a 4-star general in command of the Strategic Air Command, responsible for billions of dollars in capital investment, for the lives of thousands of military personnel and their dependents, and for the security of the entire free world as well, would earn approximately $28,380 a year, counting rations, quarters, and flight pay.

Counting flight pay and all allowances, the officer now in command of SAC draws slightly over $20,000 a year.

The Cordiner Committee has recommended similar emphasis on the higher enlisted grades, with the addition of two new grades, E-8 and E-9, within the rank of master sergeant or chief petty officer.

The "entry" pay of all enlisted grades would be increased from a few dollars a month in the case of the private fresh out of basic training to over $125 a month in the case of the master sergeant.

The Cordiner Committee also recommends a "Proficiency Pay" plan, allowing for special increases in pay, within grade, for men who have demonstrated "outstanding qualifications." The proficiency plan also could be used to induce retraining into skills critically short of qualified personnel.

An incentive system similar to this operated within the Ordnance Department of the Army between 1873 and the end of World War I with excellent results in the procurement and retention of qualified technical personnel.

To eliminate the anachronism whereby an individual who has just managed to "stay aboard" can earn more than the supervisor placed over him by virtue of ability and effort, the Cordiner Committee recommendations provide that the top pay in each grade, counting a new system of periodic, but limited, "in-grade" pay increases, would be considerably below the lowest or "entry" pay of the next higher grade.

The only remaining overlaps would be between the higher enlisted grades and the lowest officer grades and, presumably, in the case of the small number benefiting from the "proficiency pay" provision.

"The evidence of Soviet preparations and our own deficiencies are too apparent to permit the Cordiner proposals to die or be watered down."

Four principal objections have been encountered to implementation of the Cordiner Committee proposals:

1. That the granting of special incentives to technicians would place them in a privileged class as opposed to the "operating" or combat personnel of the services.

2. That the Cordiner proposals would add to rather than subtract from defense costs.

3. That retention rates of skilled personnel have increased slightly and that added incentives may be unnecessary.

4. That increases in the higher officer and enlisted grades are too high.

THE first of these objections arose before the full report of the committee was made public. The published report shows that "operating" personnel stand to benefit as directly from the Cordiner proposals as do the technicians. In addition, large groups of operating personnel retain special hazardous-duty pay, placing them well above the pay level of technicians in comparable and even in higher grades.

Charges that the Cordiner proposals would add to defense costs and hence prove "inflationary" ignore the following potent argument set forth by the committee in its report:

"If our recommendations are accepted," Mr. Cordiner admits, "some of the men and women in the armed services would receive immediate pay increases. . . . Moreover, the general levels of compensation in the armed services would rise in the coming years, as people qualify for the new and higher pay that will be available for outstanding performance. But these increases for deserving people would be more than offset by the resultant savings in matériel, operating and training costs, and personnel required to achieve a given level of national security."

Mr. Cordiner cites a test in which the Navy "selectively" staffed one carrier antisubmarine squadron with experienced personnel.

"Compared with similar squadrons," the committee chairman states, "which had the normal mixture of men at various levels of training and efficiency, the

fully trained squadron turned in a performance that was rated 30 per cent better. . . . This squadron had no aircraft accidents during its deployment to the Mediterranean as contrasted to nine accidents resulting in complete losses suffered by other squadrons of this type during the same period.

"In the Strategic Air Command," Mr. Cordiner continues, "the retention of skilled manpower now being lost would increase aircraft in-commission rates to produce an increased capability equivalent to 6½ combat-ready B-47 wings."

TO object, as reportedly have some officials, that the Cordiner proposals might well be held off in view of the slightly increased retention rates apparent since the Cordiner Committee began its work is to resort to a tactic that can only be described as "cheap," in the meanest and most tawdry sense of the word.

As with more than a few other aspects of national defense, the entire approach taken toward the Cordiner proposals by the Bureau of the Budget has been characterized, to date, by a niggardliness that, if it continues, must someday cost this Nation dear in blood and treasure.

The weakest point of the Cordiner proposals, from the standpoint of obtaining Congressional approval, is that concerning large raises for the upper enlisted grades and, in particular, the upper commissioned ranks.

The committee report provides graphic illustration of the fact that while a long overdue improvement in enlisted pay scales has been in progress for a number of years, officer pay, especially in the higher grades, has been "compressed" with the result that there "has been a continuing decline in the ultimate economic opportunity of a military career."

There is little doubt, and the committee acknowledges the fact, that pay is not always the deciding factor, or even a principal factor in the decision of some of our finest military men to make a career of the service. The number of men so highly motivated, however, is small. Nor does the Nation have the right to expect even these to make

"The Cordiner Committee expects to achieve monetary savings and increase in combat potential through application to the military of the economic incentives upon which American industry has operated since its infancy."

unreasonable economic sacrifices for the privilege of standing between the Nation and its enemies.

As has been pointed out in the case of the Strategic Air Command, even the most extreme Cordiner recommendations represent only a minor adjustment when responsibilities and the rewards of private industry are taken into account.

"In civil life," the committee report states, ". . . top executives and other employees at the upper end of the income scale have generally kept pace with the economic progress of the country. The contrast with military compensation trends is not one to inspire confidence in the military career for the intelligent and ambitious young man examining the choice between military and civilian careers.

"A sample taken of Army lieutenants," the committee report adds, "shows that the average efficiency of those officers who elect to continue in service after completion of obligated service is not equal to the average for career officers. More of the lesser qualified officers are willing to stay while more of the officers with higher potential return to civil life at the first opportunity."

Proof of the value of the Cordiner recommendations can be found in the Ordnance Department incentive system in operation until the end of World War I.

Following the Civil War, the "Cordiner Committee" of its day within the Ordnance Department made a study to determine the best method "of securing officers for taking charge of the design and procurement of the Nation's munitions."

Out of this study emerged a system by which, in 1873, the lowest grade in the Ordnance Corps was made that of first lieutenant and an examination established as a prerequisite to appointment.

Due to the fact that promotion from second to first lieutenant was then often a matter of years rather than months, as at present, the incentive of an immediate, and important, increase in rank stimulated stiff competition for Ordnance appointments among the best junior officers in the Army.

"This system was quite successful," according to the testimony of Maj. Gen. William Crozier, Chief of Ordnance at the start of World War I, "and furnished excellent officers for the Ordnance Department."

After the Spanish-American War the promotion incentive was removed.

As a result, General Crozier relates, "not only was it impossible to secure competition for detail to the Department, but there were not enough applicants for detail to fill the vacancies, and oftentimes there were no applicants at all."

THANKS to General Crozier's efforts, some aspects of the original incentive were restored, in 1906, and continued to work successfully until they were dropped, by act of Congress, following World War I.

General Crozier's arguments on behalf of the incentive system for his technical personnel bear even more weight today then they did formerly.

"No characteristic of this mechanical age is more pronounced," General Crozier wrote, "than the complete entry of its spirit into the production of implements and engines of war. . . . It does not suffice to have good soldiers, good officers, and good armament if the enemy has better soldiers, better officers, and better armament."

The evidence of Soviet preparations and our own deficiencies are too apparent to permit the Cordiner proposals to die or be watered down in the supposed interests of false "economy."

The men who design, maintain, and use the machines of war, and not the machines themselves, will determine whether we or the Soviets survive the great test of strength in which we are now engaged.

THE CAPABILITIES AND TECHNIQUES OF

The Thirty-ninth Annual Industrial Preparedness Meeting of the American Ordnance Association will be held on Wednesday, December 4, 1957, at the Waldorf-Astoria, New York City, in coöperation with Cornell Aeronautical Laboratory, Inc. There will be morning and afternoon seminars, an Armament Preparedness Luncheon, and the annual Industrial Preparedness Dinner. The seminars will be presided over by A.O.A. Vice-President Louis Polk, president of The Sheffield Corporation, Dayton, Ohio, and vice-president of Bendix Aviation Corporation, New York, N. Y. Seminars will be held on the Starlight Roof. The complete program follows:

Morning Session — 9:30 o'clock — Starlight Roof

PART I: GENERAL REQUIREMENTS FOR LIMITED WAR

PANEL LEADER

IRA ROSS, *Director, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y.*

This panel of official speakers from the military will discuss military requirements, capabilities, and plans. A limited war is defined as one fought to achieve a limited objective. In the achievement of this objective a nation may be expected to plan to expend a limited amount of its national resources and to hold the war to a limited geographical area.

THE ARMY IN LIMITED WAR

MAJOR GENERAL JOHN P. DALEY, *Director, Special Weapons, Office, Chief of Research and Development, U. S. Army, Washington, D. C.*

TACTICAL AVIATION IN LIMITED WAR

GENERAL O. P. WEYLAND, *Commander, Tactical Air Command, Langley Air Force Base, Va.*

THE NAVY IN LIMITED WAR

VICE ADMIRAL W. V. DAVIS, JR., *Deputy Chief of Naval Operations (Air), Washington, D. C.*

THE MARINES IN LIMITED WAR

BRIGADIER GENERAL RICHARD C. MANGRUM, *Assistant Deputy Chief of Staff for Operations, Marine Corps Headquarters, Washington, D. C.*

Midday Session — 12:30 — Starlight Roof

ARMAMENT PREPAREDNESS LUNCHEON

PRESIDING

LIEUTENANT GENERAL LESLIE R. GROVES

President, New York Post, American Ordnance Association; Vice-President, Remington Rand Division, Sperry Rand Corporation, Bridgeport, Conn.

ADDRESS

LIEUTENANT GENERAL JAMES M. GAVIN

Chief of Research and Development, United States Army, Washington, D. C.

AMERICAN ARMAMENT FOR LIMITED WAR

Afternoon Session — 2:45 o'clock — Starlight Roof

PART II: RESEARCH AND DEVELOPMENT OBJECTIVES FOR THE IMPROVEMENT OF LIMITED WAR CAPABILITIES

PANEL LEADER

ROBERT SHATZ, *Head, Systems Research Department, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y.*

AIRCRAFT IN LIMITED WAR

DR. HALL L. HIBBARD, *Senior Vice-President, Lockheed Aircraft Corporation, Burbank, Calif.*

MISSILES IN LIMITED WAR

DR. C. C. FURNAS, *Chancellor, University of Buffalo, Buffalo, N. Y.*

ELECTRONICS DEVELOPMENTS IN LIMITED WAR

DR. EMANUEL R. PIORE, *Director, Research and Development, International Business Machines Corporation, New York, N. Y.*

ECONOMICS OF A DUAL CAPABILITY

DR. MALCOLM W. HOAG, *Economist, Rand Corporation, Santa Monica, Calif.*

Evening Session — 7:30 o'clock — Grand Ballroom

INDUSTRIAL PREPAREDNESS DINNER

PRESIDING

LIEUTENANT GENERAL LESLIE R. GROVES

President, New York Post, American Ordnance Association; Vice-President, Remington Rand Division, Sperry Rand Corporation, Bridgeport, Conn.

TOASTMASTER

GENERAL BENJAMIN W. CHIDLAW

President, American Ordnance Association; Vice-President, Thompson Products, Inc., Cleveland, Ohio

AWARD OF THE WILLIAMS GOLD MEDAL TO

HONORABLE DONALD A. QUARLES

Deputy Secretary of Defense
Washington, D. C.

ADDRESS

HONORABLE DONALD A. QUARLES

Supersonic Airpower

The Air Force's supersonic family of "century series" aircraft are shown above. Clockwise from the bottom are: the Lockheed F-104 Starfighter, an air-superiority fighter that can carry the new 20-mm. Vulcan gun; the North American F-100 Supersabre, armed with four 20-mm. cannon; the Convair F-102 Dagger, an all-weather delta-wing interceptor armed with both Falcon air-to-air guided missiles and 2.75-inch folding-fin rockets; the McDonnell F-101 Voodoo which carries four 20-mm. rapid-firing cannon and up to six Falcon missiles; the Republic F-105 Thunderchief, a nuclear-weapons-carrying fighter-bomber with short, very thin sweptback wings and a long cylindrical fuselage. Air feeding its J57 jet engine is through wing-root intake ducts (Air Force photo).

Defense Highlights: Monthly Review and Outlook

• **Limited War.**—Limited war versus massive retaliation is a seething question in the Defense Department, aggravated by stringent budgeting. Discussion revolves around whether retaliatory forces are adequate for fighting limited wars in this period of tight defense money.

The belief of proponents for massive retaliation was expressed by Gen. Thomas D. White, Air Force Chief of Staff: "When resources are critical, forces must be tailored, with survival forces, in whatever service, holding their priority at the cost of other forces." Survival forces are defined as the retaliatory Strategic Air Command and the ICBM.

This philosophy would reduce our tactical air support and troop carriers. Ground force leaders view this situation with alarm. In the realization that they would bear the brunt of any limited or brush-fire war, they feel strongly the need for adequate mobile forces, numbers of close-support missiles and aircraft, and adequate air support to make them thoroughly mobile both for overseas movement and in the zone of battle.

Gen. Maxwell D. Taylor, the Army's Chief of Staff, said: "If we attempt to suppress it (a small outbreak) with insufficient means, or with insufficient speed of reaction, we run the risk of allowing a small war to grow into the great atomic war which it is our purpose to avoid."

This question is further confused because there is no announced policy regarding the use of nuclear weapons in a limited war or even an official accepted definition of limited war.

• **Production Procedures.**—Project management techniques seem to have joined "rôles and missions" as a prime subject of discussion regarding missile programs in the Defense Department. The long-used method of maximum weapons development by a service and production by industry is rivaled by the new approach, backed principally by the aircraft industry. This is a trend to one prime contractor who would receive the military requirement for a missile systems project and undertake the entire development and production.

In either method the operational forces have an opportunity to ensure that the end product at least is adequate and usable. The true effectiveness of the weapon thus depends on the degree of combat wisdom that is introduced into the development stage. Either method is a far cry from pre-World War I, when the operating units were forced to take whatever fighting equipment the powerful technical branches and bureaus thought was best.

From the present variations in development and production procedures is expected to come an approach that will emphasize the best features of each.

• **Navy Missile.**—Initial flight tests for the Navy's fleet ballistic missile, the 1,500-mile Polaris, are expected this fall—ahead of earlier predictions. In addition to Aerojet-General Corporation, it is understood that the Navy Bureau of Ordnance has Thiokol Chemical Corporation working under an Army contract to develop a solid-propellant propulsion system. The Navy has a difficult problem in trying to produce a large missile that can be squeezed into a submarine.

• **Russian Satellite.**—Two features of the first Russian satellite that stand out are its propaganda effect and its heavy weight. Given the capability, it was not difficult for Russia to launch a satellite first since our Vanguard project was publicly announced originally for launching early in this Geophysical Year. Advance notice plus crash program equaled a propaganda victory that has impressed all the world.

Technically, it was a major achievement that has our scientists bursting with curiosity. They would like to know whether a series of monster rockets were used by the Russians or whether new propellants were employed, five times superior to ours, in order to put a weight nine times greater than the Vanguard into an orbit 600 miles high.

No additional amount of money can undo the fact that, propagandawise, we have been outsmarted; but, from the resulting political hue and cry, our leading scientists are hopeful that the U. S. will pay more attention to basic research—an essential background to any crash program.

• **Action in the Antarctic.**—U. S. Naval and scientific units are pouring into the Antarctic in operation Deep Freeze III in support of our contribution to the International Geophysical Year. Commander of the support force is Rear Adm. George Dufek, who has the additional duty of U. S. Antarctic Projects Officer.

Three hundred and twenty naval, Marine, and scientific personnel have been wintering in the seven U. S.-manned stations in Antarctica. Most of these men will be relieved and about 25,000 tons of cargo and 666,000 gallons of petroleum products will be brought in by ship and air force and naval aircraft.

These resupply groups are proceeding from such far-flung places as Capetown, South Africa, and Christchurch, New Zealand, after first loading in the United States.

At the seven stations, the scientific parties will continue to collect information on geology, meteorology, ionospheric physics, and study the aurora and air-glow phenomena, while support personnel repair equipment and improve landing areas, trails, and housing.

• **More Satellites.**—It is now revealed that the United States is contributing more than the 20-inch Vanguard to the IGY satellite program. Scientists are preparing seven types of satellites ranging from six inches to thirty inches, to test

earth's magnetism, sample ionospheric temperatures, count meteorites, measure erosion of meteorite dust, and test solar battery effectiveness.

Inspired by world interest in their satellite, Russian scientists in this country and at the International Astronautical Federation meeting in Barcelona dropped hints of their next two objectives—a television-carrying satellite to watch the world and a rocket to the moon. Our scientists got the impression that Russian developments were being speeded.

• **International Navy.**—The large-scale NATO fleet exercises this fall were the most comprehensive to date and revealed the increasing power of this "international" navy. A critique of the "Strikeback" phase, conducted northwest of Norway, brought out the effectiveness of antisubmarine tactics and fleet defense against land-based air attack and emphasized the versatility of naval aircraft for missions ranging from long-range bombing (with simulated nuclear weapons) to close support of troops.

Although the operations were successful, both American and British naval leaders expressed deep concern over the inadequacy of the numbers of ships available in the NATO fleets.

The principal difficulty, as in previous maneuvers, was communications, especially from ships to NATO commands ashore, when usual impediments of procedure and language were increased by electromagnetic disturbances. Also, some of the new U. S. naval aircraft in the FORRESTAL-class carriers experienced operational difficulties that will cause needed modifications to be expedited.

Nine carriers and about one-hundred other combat ships were engaged in this exercise alone. Altogether, about 400 ships of the alliance took part in the whole series that made up the over-all war game that concluded with four days of successful British-American combined carrier operations.

• **British Bombers.**—In a further indication of British-American unity, four Royal Air Force jet bombers are participating in the annual proficiency competition now taking place at Strategic Air Command bases in Florida and Texas. Bomb crews are vying for trophies in bombing, navigation, and reconnaissance.

• **Business and Defense.**—Small business was awarded approximately twenty per cent of the Defense Department's prime contracts in fiscal 1957. This was the same percentage as in fiscal 1956 but a nine per cent increase in dollar value. In addition, a tremendous amount of subcontracting was undertaken by small business for the large prime contractors. Arranging for these awards required the studied efforts of a large number of officials in the Department of Defense and the Small Business Administration.

• **New Logistic Concept.**—The air-water logistic concept proposed in connection with the SeaMistress, a huge seaplane on the Martin Company's drawing boards, has great possibilities. The proponents of this system envision a self-supporting organization with waterborne, U-shaped unloading floats, floating oil-storage and routine maintenance structures that would use lakes and rivers, as well as harbors and inlets. They also claim that present air and sea logistic support is inadequate for countering a small war action and that, by scrapping present slow, cumbersome methods, the program would be accomplished within budget limitations.

The key to this concept, the SeaMistress, is an improved SeaMaster, doubled in size to carry 130 tons 1,000 miles or an equipped infantry company 500 miles. Drop-in and run tactics could be used to supply our forces in forward areas, if water is at hand, by use of floatation gear on supplies and equipment. With success expected in the trials of the SeaMaster, this air-sea logistic proposal has merit.

• **Safety Aloft.**—The Air Force and Navy both have set all-time safety flying records. The Air Force reports only 14 major accidents per 100,000 hours in 6 months of 1957; Navy reports 3.06 per 10,000 hours in fiscal 1957. The relative difference in hazard is that only about thirty per cent of naval flying is in less accident-prone, multiengined craft whereas Air Force flying, which includes that of the Military Air Transport Service, is seventy per cent in multiengined types.

• **Balloons and Science.**—The many experimental balloon flights being directed by the services will add greatly to our knowledge of outer space and increase data being collected through IGY-sponsored flights. Most spectacular is Air Force's Far Side project utilizing a balloon that rises to 100,000 feet and then fires an instrumented rocket another several hundred thousand feet. In tests, the balloon successfully carried 2 tons of equipment to an altitude of about 106,000 feet.

Navy projects include the 10-year-old Skyhook program primarily for cosmic-ray study; Stratolab, a pilot and scientist team ascent scheduled two or three times yearly; launching of unmanned balloons with cameras to photograph celestial bodies; and weekly flights to study the atmosphere's composition.

The Atomic Energy Commission also has frequent balloon flights made to sample the content of radioactive particles in the upper air.

• **Missile Support Plan.**—The Air Force has started a logistic program to establish an economical missile upkeep and resupply. It entails a comprehensive network of data-processing and communication equipment so that parts and replacements can be rushed quickly from industry to combat units.

An Air Matériel Area commander will be responsible for support of one or more missile systems. He will relay requirements to the appropriate producer for direct shipment to save stockpiling and extra handling. Small missiles will be replaced and returned complete for "treatment." Big IRBM and ICBM missiles that do not check out will be disassembled at the site and components returned for repairs.

This program, which will take about ten years to complete, will make industry a close partner in the Air Force missile logistics chain.

The Budget and Defense

An Editorial

THE most recent edict that directed another reduction in our military forces, the periodic announcements of closing bases and plants, and the cancellation of missile projects sum up to an apparent grave weakening of the military strength of the United States.

Our citizens must think that either the over-all cut to protect our economy was so heavy that administrators hesitated to announce it all at once or that the economics of operating the vast defense enterprise is so complex that no one can tell what its financial position is at any one time.

Whatever the reason, the sum of all the reductions makes an alarming total, especially in manpower, when we see no equivalent reduction in the forces that threaten us or increases in strength on the part of our allies.

The most recent manpower reduction was accompanied by a statement by then Secretary of Defense Charles E. Wilson, that the new force levels could be introduced "without impairment of our national security." He indicated that improved efficiency, technological advances, smaller but more mobile forces, and reduced personnel turnover would offset the decrease in personnel. The Secretary also predicted that there would be a third reduction of approximately another 100,000 in connection with the fiscal 1959 budget.

ON the surface this does not make sense, because the end result of the reductions is announced to be fewer divisions (not the present number made smaller and more mobile), fewer ships, and fewer aircraft. Can it be that in the next two years the remaining divisions, ships, aircraft, and personnel, because they use more technologically improved weapons, are going to give us the same degree of national security? That seems most unlikely and calls for closer examination of the situation to reveal how reductions can be justified as not weakening our national security.

On the skeptical side, we find that Government spokesmen disregard military requirements, proclaiming only that to protect the national economy the defense budget must not exceed $38 billion; yet, little is said about the soaring cost of the many paternalistic measures that pour out of our legislature or the nonessential items in foreign aid.

This leads the serious citizen to think that billions are going to captivate the voters but a bare minimum to preserve our national defense. Furthermore, when one sees no reduction in Communist ground forces or their rate of producing submarines, aircraft, and missiles, it is no wonder that our own reductions in force are baffling.

Statements of service leaders show that they are making every effort to economize. Some of them, in accepting the first personnel cut, announced that they would rather save money on manpower than drastically reduce their armament developments. This philosophy appears to be based on an increasing readiness to accept greater calculated risks, in that we will be less prepared for rapid mobilization, thus approaching our status before Korea when there were inadequate forces in being to stem the hordes of Communist-inspired orientals.

A DEEPER study of the situation reveals some long-range good that can be obtained from a properly coördinated reduction in manpower. The most hopeful outlook lies in reducing the number of men with low intelligence quotients who are now inducted into service. With higher standards, fewer numbers, and an increased percentage of dedicated personnel, better *esprit* can be developed in the armed forces. In turn this will give a better base for rapid and effective mobilization.

It also would be a blessing to all services in the field if the reduction could be applied liberally to the ever-growing, empire-building bureaucracy that is forever dreaming up additional burdensome reports and other tasks for our operating divisions, fleets, and air wings.

The Department of Defense itself has grown from a small handful of policy makers to many hundreds of men perpetually attempting to "coördinate" the military effort. The bureaucratic burden is indicated further by the civil service employment in the Department of Defense, which has increased by thousands since the Korean war when the budget was about $60 billion.

It may be possible even to improve the practices that lead to the enormous waste in the sending of spare parts to our Arctic bases. Perhaps, with fewer men and more business machines, a better accountability system will develop. At every base criticized for the mishandling of spare parts, one excuse given was the necessity of using poorly trained men with inadequate learning. Thus, much good could be made of the planned reductions within the Defense Department.

At the same time the situation will require even greater understanding and closer coöperation on the part of industry. Thirty-eight billion dollars, of which roughly half goes to development and production, is no small part of the gross national product.

To ensure that our national security truly is not weakened will depend a great deal on the ability of American industry to reduce its costs and work closely with the services in the development of weapons, not only to derive the best but also to help them eliminate the less effective ones. This is a great challenge which should appeal to all members of the American Ordnance Association.

ASSOCIATION AFFAIRS

Large Turnout Attends First Meeting Of Far East A.O.A. Post In Tokyo

The newly formed A.O.A. Far East Post in the Tokyo, Japan, area reports that the inaugural meeting was attended by 153 charter members—a record turnout by any organizational standard. Among those present were members from Korea, Okinawa, and the Philippines who attended to witness the ceremonies and discuss the matter of forming A.O.A. Chapters in their areas. The Post plans to hold other meetings in the future.

At Tokyo meeting were, left to right: Maj. Gen. R. L. Maxwell, former president, New York Post; Brig. Gen. H. F. Bigelow, Post advisory board; Herman Ramph, vice-president; L. A. Martin, president; J. J. Mehaffey, secretary; J. K. Gleason, treasurer.

In addition to the Post officers and directors previously reported, the following advisory board has been established: Brig. Gen. Horace F. Bigelow, Ordnance Officer, U. S. Army, Pacific; Col. Francis G. Hall, Deputy for U. S. Support, Headquarters, Army Forces, Japan; Col. Frederic Eichorn, commanding officer, U. S. Army Ordnance Depot, Oppama; Col. Jefferson Childs, commanding officer, U. S. Army Ammunition Depot, Japan; Col. B. B. Abrams, commanding officer, U. S. Army Logistical Depot, Japan; Lieut. Col. Arthur Smith, commanding officer, U. S. Army Ordnance Subdepot, Tokyo; Lieut. Col. Taylor Carney, executive officer, U. S. Army Ammunition Depot, Japan.

Syracuse Chapter Holds Annual Outing At Lake Shore Yacht Club, Oneida

The Syracuse Chapter's eighth annual outing meeting was held at the Lake Shore Yacht and Country Club, Oneida, N. Y., on Wednesday, July 31st.

Golf and many water activities were enjoyed during the afternoon by over two hundred members and their guests, including many from the Rochester and Buffalo Chapters of the Empire Post and a large turnout from the Army, Navy, and Air Force.

Upon the conclusion of a picnic-style buffet supper, George R. Auld of Carrier Corporation, Chapter president, introduced the guest speakers. In the first talk, Col. W. A. Davis, commanding officer of the Rochester Ordnance District, gave a brief reappraisal of the capabilities of New York State industry to fit into atomic and missile work. He stressed the importance to industry of maintaining a close tie with the A.O.A. in order to keep abreast of developments.

Col. A. S. Young, chief of the Rochester Air Procurement Office, discussed the trend of increasing missile expenditures while aircraft outlay dropped and outlined the services to industry that were undertaken by his office.

The program chairman was Daniel H. Robinson, Precision Castings Company, assisted by Fred Gangberg, General Electric Company, who was in charge of the reception. Harvey Kasso, Precision Castings Company, was in charge of the golf tournament, and a host of others contributed to a most successful affair.

A.O.A. Executive Committee Holds Fall Meeting At Headquarters In Washington

The Executive Committee of the Board of Directors of the American Ordnance Association held its fall meeting at national headquarters on Wednesday, September 11th. Members of the Executive Committee present were Gen. B. W. Chidlaw, president of the Association; Harvey C. Knowles and Louis Polk, vice-presidents; and the following directors: Lieut. Gen. Levin H. Campbell, Jr., Col. John S. Pfeil, Col. Henry N. Marsh, S. E. Skinner, and Col. Leo A. Codd, executive vice-president.

A review of operations during the first half of 1957 was presented by members of the headquarters staff responsible for fiscal matters, membership, publications, Technical Divisions, and Posts. It was evident from these reports that the affairs of the Association are thriving. Membership continued to grow; the publications were in great demand; the Technical Divisions and Posts enjoyed a period of increased activity.

Among the matters of general interest discussed by the Committee were Crozier House, the privileges of company members, and the plans for the annual Industrial Preparedness Meeting in New York on December 4th.

It was recommended that the Board of Directors reëxamine the matter of moving A.O.A. headquarters to Crozier House in view of further long delays in a decision on zoning in the city of Washington and the ever-rising costs of construction.

The Executive Committee concurred that company memberships should be made more attractive by more widespread publicity and participation in Technical Division meetings. The Committee approved of the plans for the Annual Industrial Preparedness Seminar where the

topic would be "Capabilities of American Armament for Limited War" with speakers from the Department of Defense in the forenoon and from industry in the afternoon to discuss the requirements and the means available to meet them in the event of a limited war.

The Committee adjourned and proceeded to the Army-Navy Club for a luncheon in honor of the armed forces' military leaders in armament and ordnance. Guests at the luncheon were:

From the Air Force—Lieut. Gen. D. L. Putt, Deputy Chief of Staff, Development; Lieut. Gen. Samuel E. Anderson, Commander, Air Research and Development Command.

From the Office of the Chief of Army Ordnance—Lieut. Gen. E. L. Cummings, Chief of Ordnance; Maj. Gen. J. H. Hinrichs, Deputy Chief of Ordnance; Maj. Gen. August Schomburg, chief, Research and Development Division; Maj. Gen. F. A. Hansen, chief, Field Service Division; Brig. Gen. Francis J. McMorrow, chief, Industrial Division.

From the Navy Bureau of Ordnance—Rear Adm. F. S. Withington, Chief of the Bureau; Capt. M. A. Peterson, Assistant Chief for Material; Capt. E. B. Hooper, Assistant Chief for Research and Development.

Frontier Chapter Holds Outing and Dinner Meeting At Niagara Falls Club

The Frontier Chapter of the Empire Post held a combined golf outing and dinner meeting on September 19th at the Niagara Falls Country Club, Buffalo, N. Y., where over one hundred representatives of industry and the armed forces gathered.

After the reception and dinner meeting, the presiding officer, John J. O'Neil, of Cornell Aeronautical Laboratory, Inc., Chapter chairman and a vice-president of the Empire Post, introduced the master of ceremonies, Claude Wright, president of the Empire Post and president of Page Airways. Mr. Wright presented the guest of honor, Dr. Clifford C. Furnas, chancellor, University of Buffalo, and formerly Assistant to the Secretary of Defense for Research and Development, who talked informally on current research and development problems.

Other guests at the speakers' table included Col. William Davis, commanding officer, Rochester Ordnance District; Col. Allan Young, Chief, Rochester Air Procurement District; Comdr. Edward Bull, Navy Bureau of Aëronautics representative; and Comdr. Stanley Caplan, inspector of naval material.

Maj. Gen. Everett S. Hughes Was Seventeenth Chief of Ordnance

Maj. Gen. Everett Strait Hughes, seventeenth Chief of Ordnance of the Army in a long line of distinguished military leaders, died at Washington, D. C., September 5, 1957. He was Chief of Ordnance from 1946 to 1949. He became a member of the Ordnance Association the day it was founded in 1919.

His military career was marked by many diversified and responsible assignments. When General Hughes retired from active service in 1949 he had completed forty-one years of notable service in the Army, thirty-eight of which were spent in the Ordnance Corps. All his service was marked by rugged vitality and great singleness of purpose.

General Hughes was born in Ipswich, S. D. He was graduated from the United States Military Academy at West Point in 1908 as a second lieutenant of Field Artillery but remained at the Academy to serve as an instructor. As a field artilleryman he served at Fort Snelling, Minn., and Fort Sam Houston, Tex. In 1911 he was accepted by General Crozier, then Chief of Ordnance, for detail in the Ordnance Department—an assignment indicative of unusual ability and administrative leadership. His entire remaining military career was spent in that important branch of the Army.

General Hughes' first combat service was with the Mexican Punitive Expedition in 1916. There he assisted in the development of the Army Ordnance mobile field repair service.

Throughout World War I, General Hughes served in the Office of the Chief of Ordnance in Washington as chief of the artillery section of the Procurement Division. At war's end he was assigned to the War Claims Board in Chicago and in the following year became Ordnance Officer of the Central Department at Fort Sheridan, Ill., and later Ordnance Officer of the VI Corps Area.

Thereafter followed duty at the Aberdeen Proving Ground and at Picatinny Arsenal. In 1939 he returned to the Office of the Chief of Ordnance in the Field Service Division.

During these years General Hughes completed the courses of study at several of the Army's leading schools. He was graduated from the old Army School of the Line in 1922, the General Staff School at Fort Leavenworth in 1923, the Army War College in 1928. Following his graduation from Leavenworth he served a 4-year tour as instructor at the General Staff School.

It was in 1942 with the advent of the European war that General Hughes, through his long and close association with General Eisenhower, was given broad responsibilities in the European theater of operations. In that year he went to England as Chief Ordnance Officer of the theater, becoming Chief of Staff, Services of Supply, where he participated in the planning for the North African invasion.

Maj. Gen. Everett S. Hughes

Later he became Chief of Staff of the European theater of operations and was deputy commander for the North African theater.

Upon the completion of the North African campaign, General Hughes became a special assistant to General Eisenhower for the invasion of Europe and served in Headquarters, SHAEF. He completed his overseas duties as inspector general of the U. S. Forces in the European theater of operations.

Upon his retirement as Chief of Staff of the Army in 1948 General Eisenhower wrote to General Hughes:

"Throughout the campaigns of Northern Africa and Germany I was extremely fortunate to have as my trouble shooter and personal representative in the field a man of your professional ability, judgment, and character. I can never thank you enough for the load you took from my shoulders during those trying years. Your service as Chief of Ordnance in the postwar period has been characterized by the same zeal and devotion to duty. It has been a comfort and reassurance to have you continuing as a member of my staff."

General Hughes was named Acting Chief of Ordnance in February 1946 and became Chief of Ordnance in June of

that year, serving in that capacity until his retirement. During his tenure as Chief a great part of his effort was devoted to the salvaging and reconditioning of Ordnance equipment in both the European and Pacific theaters and to the determination of plans and policies regarding the operations of the Ordnance Corps in the postwar era.

His policies in the latter respect followed the traditional Ordnance pattern of relying upon the Ordnance arsenals for the training of military and civilian personnel in the development and pilot-line production of noncommercial ordnance. He also leaned heavily upon the technical Divisions and Committees of the American Ordnance Association in the problems relating to the production engineering of new types of armament, and the A.O.A. is indebted to him for his support in this important field.—L.A.C.

Ford Motor Company Is Host To More Than 1,000 Members of Michigan Post

Del S. Harder, executive vice-president of the Ford Motor Company and president of the Michigan Post of the Association, was host to more than 1,100 members of the Post at a day-long meeting on September 17, 1957. Assisting Mr. Harder were officers and members of the Post, led by Irving A. Duffy, a vice-president of the company and a member of Council of the Association; and Don Pipple, N. S. Oates, and John Coombe of his staff.

Guests included Lieut. Gen. E. L. Cummings, Chief of Army Ordnance; Gen. B. W. Childlaw, president of the Ordnance Association; and many ranking officers of the Army, Navy, and Air Force. Industry throughout the Michigan area was represented by many of its leaders.

The meeting was held at the Ford Motor Company headquarters, Dearborn, Mich. Beginning at 10 a.m. and continuing throughout the day, the facilities of the great Ford River Rouge Plant were inspected, and an unusual display of American armament featuring many of the latest missiles was on view. Buffet luncheon was served on the spacious lawns adjacent to the Rotunda. Tours were organized throughout the day to take members through the plant properties, including the exhibits in the Rotunda, the steel mill, and the assembly line. Tours also were conducted through the Dearborn Engine Plant. There were also morning and afternoon tours of Greenfield Village and the Ford Museum.

"The industry-military team will continue to keep America supplied with effective weapons," said General Cummings as he viewed the new military weapons shown in the Ford Rotunda. He praised Detroit and Michigan business leaders for presenting the unique display to the public. He said: "I am impressed by the display of new military equipment which has been assembled here for the Michigan Post of the American Ordnance Association. It reflects the efficiency and ingenuity of the American industry-military team in devising means of keeping our country strong and prepared to defend our people against any form of aggression."

General Cummings added: "While these weapons and vehicles are the product of the combined effort of American industry, Michigan industry and workers have contributed importantly to the overall result. As a native of this great State, I am especially happy to pay tribute to its contribution to a strong America. The Michigan Post members of A.O.A. deserve the highest commendation for cooperating with the military services to present this visual evidence of our military progress."

The new missile-equipped, "airborne and air-droppable" Army was highlighted in the modern war equipment, with special emphasis on missiles and rockets. The meeting, however, inferentially also stressed the importance of maintaining American strength in conventional weapons, such as ground fighting equipment and the new small arms.

Missiles and rockets at the exhibit included the Army's Corporal, Dart, Honest John, Redstone, and Nike; the Air Force's Operation Far Side and Falcon; and the Navy's Sidewinder and Talos.

Other atom-age items in the display were the aërocycle, the one-man helicopter of the Army Transportation Corps; an atomic-warfare "diorama" display by the Army Engineers; a pilot model of the Edison Company's atomic power plant at Monroe, Mich.; both "male" and "female" versions of the Army's new-airborne Mechanical Mule; the Air Force's fabulous upper-air rocket, "Operation Far Side"; the Navy's portrayal of its newest "flattop" aircraft carriers; and a special showing of Marine weapons.

Also shown was equipment of the famed 101st Airborne—the first "pentomic division" to be ready at short notice to fly off for a police action. The Army is prepared for the possibility that the massive nuclear weapons may cancel all-out war and that the greatest problem facing the United States is getting ready for a police action or limited war, with or without nuclear weapons.

The pentomic division has five combat groups, each one independent of the others and completely able to fend for itself, eliminating the possible severance of a single communication line and making for a smaller target.

Military personnel, skilled in the design and operation of the various pieces, were on hand to explain the engineering details and manufacturing requirements involved.

Attending Michigan Post meeting were, left to right: Irving A. Duffy, A.O.A. Council; Maj. Gen. Nelson M. Lynde, commanding general, Tank-Automotive Command; Lieut. Gen. E. L. Cummings, Chief of Army Ordnance; Del S. Harder, Post president.

Fire Control Committee Of Underwater Ordnance Division Meets At Garden City, N. Y.

The recently reorganized Fire Control Committee of the Underwater Ordnance Division held a meeting at the Arma Division, American Bosch Arma Corpo-

ration, Garden City, N. Y., on August 20-21, 1957.

Presiding at this meeting was the newly appointed chairman, Alton D. Anderson, Cook Research Laboratories, Morton Grove, Ill., assisted by Deputy Chairman Richard Y. Miner, Arma Division, and Secretary Roy C. Schoenhaar, Ford Instrument Company, Division of Sperry Rand Corporation, Long Island City, N. Y.

Welcoming addresses were made by Mr. Gittens, general manager of the Arma Division and Mr. Goetz, chief engineer, who briefly outlined Arma's current activities and fields of interest.

Chairman Anderson then discussed several items of interest to the committee as a whole and appointed the following two subcommittees: (1) Records and Communications—John J. Ryan, Daystrom Corporation, Woodside, N. Y., chairman; M. W. Arsove, Raytheon Manufacturing Company, Wayland, Mass., deputy chairman; (2) Weapons Alignment and Evaluation Subcommittee—Wayne G. Shaffer, Vitro Laboratories, Silver Spring, Md., chairman; Paul Cohen, Sperry Gyroscope Company, Great Neck, N. Y., deputy chairman; and R. A. Cunningham, Crosley Division, Avco Manufacturing Corporation, Cincinnati, Ohio, secretary.

Also appointed was the executive staff of the Fire Control Committee consisting of the chairman, deputy chairman, and secretary of the Committee together with the chairmen of the two Subcommittees and Capt. C. B. Stevens, Navy Bureau of Ordnance, Washington D. C.

The balance of the first day and the morning of the second day were devoted to individual Subcommittee meetings. The Committee as a whole was reassembled by Chairman Anderson after luncheon on the second day to receive the reports of the Subcommittee chairmen.

A.O.A. 20-mm. Fuze Committee Holds Annual Meeting At Kingsbury Ordnance Plant

The annual meeting of the 20-mm. Fuze Committee of the A.O.A. Small Arms and Small Arms Ammunition Division was held at the Kingsbury Ordnance Plant, La Porte, Ind., on June 11 and 12, 1957. Chairman Edward J. Lauenstein, presided.

Kingsbury Ordnance Plant, operated by ASR Products Corporation, was host to the meeting, and Sidney Weil, president of ASR welcomed the members on behalf of the company, Kingsbury Ordnance Plant, and American Ordnance Association.

Mr. Weil praised the teamwork of industry and the armed forces as typified by the A.O.A. "Although A.O.A. is an unofficial organization," he said, "if it did not exist it would have to be invented in order to catalyze and bring together industry and the armed forces so that the problems confronted by both could be followed through from beginning to end with mutually satisfactory results."

Among those at 20-mm. Fuze Committee were, front row, left to right: E. J. Lauenstein, chairman; Col. J. P. Harris, B. M. Finnigan, Sidney Weil, Brig. Gen. Joseph Colby, Lieut. Col. E. W. Worthing, Capt. J. E. Bess, W. S. Aumen, Jr.

Prior to becoming president of ASR he had been executive vice-president of the company and general manager of the Kingsbury Ordnance Plant from its reactivation in 1951.

Capt. J. E. Bess, commanding officer, Kingsbury Ordnance Plant, introduced the guest speaker, Brig. Gen. Joseph N. Colby, commanding officer, Ordnance Ammunition Command, Joliet, Ill. General Colby expressed confidence in the teamwork between industry and Ordnance in perfecting and delivering to the armed forces the best ammunition that the combined efforts of such a team could produce.

In a plea for new ideas, the General pointed out that if every one of the sixty-four men present were to put one idea on the table, each would leave the meeting with sixty-three new ideas.

The rôle of 20-mm. ammunition in the Air Force was presented by Lieut. E. B. Warren, Jr., of Eglin Air Force Base, Fla., who discussed its major part in

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ground-support work with the fighter-bomber tactical forces.

Lieut. Col. L. W. Worthing of the Ordnance Ammunition Command, explained the M505 fuze and 20-mm. ammunition for the M39 and T171 guns.

The present status on the HEI 20-mm. round was detailed to the Committee by W. S. Aumen, Jr., of Eglin Air Force Base. The quality-assurance test program of the Air Force in connection with this round was a great enlightenment to the members.

Additional discussions and papers were presented by Ellis W. Read of Frankford Arsenal and by H. Kline, J. Piskorski, and Willard Smith, all of Lake City Arsenal. Mr. Piskorski delivered a paper on the history and current status of the 20-mm. fuze, PD M505 series. Mr. Smith presented a paper on the "Importance of Careful Quality Assurance Procedures" for this fuze.

The papers presented by the consultants and speakers provided valuable information and were of great assistance to the suppliers and inspectors of metal parts for the current M505 fuze.

A discussion period followed the programmed part of the meeting, and there was a conducted tour of the 20-mm. ammunition loading lines at Kingsbury Ordnance Plant.

ASR was host at a dinner party in honor of the members, consultants, and guest speakers on the evening of June 11th.

A.O.A. Small Arms Groups Attend Special Meeting at Springfield

At the request of Maj. Gen. August Schomburg, Assistant Chief of Ordnance for Research and Development, the executive board of the Small Arms and Small Arms Ammunition Division, and members of the Rifles and Carbines, Machine Guns, Pistols and Revolvers, and Small Arms Ammunition Committees held a special secret meeting at Springfield, Mass., on September 18, 1957. The principal purpose of this meeting was to witness a presentation of the small arms and small-arms ammunition development program. Forty-eight representatives of industry and sixteen Government representatives attended.

Following introductory greetings by Col. Douglas G. Ludlam, commanding officer of Springfield Armory, Division Chairman Maxwell R. Warden introduced Brig. Gen. Burton O. Lewis, representing American Ordnance Association national headquarters, and Brig. Gen. William K. Ghormley, commanding general, Ordnance Weapons Command. He then introduced General Schomburg, who presented a statement of the program and presided over the technical session.

The speakers on General Schomburg's panel and their subjects were: Charles E. Dickey, Frankford Arsenal, "Ammunition"; Dr. A. J. Dziemian, Army Chemical Center, and Joseph Sperrazza, Aberdeen Proving Ground, "Ballistics"; Earl M. Harvey, Springfield Armory, "Small Arms Weapons Mechanisms"; and Dr. Kenneth L. Yudowitch, Ordnance Research Office, "Hit Probability Problems." The program closed with a summary by General Schomburg.

In the afternoon the speakers from the morning session constituted a panel under the chairmanship of Dr. Fred H. Carten, Office, Chief of Army Ordnance, to answer specific questions from the audience concerning the development program.

Col. Glenn E. Nida, chief, Ammunition Section, Industrial Division, Office, Chief of Ordnance, discussed the industrial small-arms ammunition program, and Col. Oscar G. Kreiser, deputy commander, Ordnance Weapons Command, reviewed the status of the M14 rifle and M60 machine-gun programs.

A short meeting of the executive board of the Division followed.

This presentation was representative of the policy recently announced by Lieut. Gen. E. L. Cummings, Chief of Army Ordnance, for keeping industry advised of the progress and needs of the Ordnance Corps. Many A.O.A. Division members expressed the feeling that if this presentation was representative of the approach to be taken by Ordnance, it heralded a new day in the partnership of Ordnance and American industry.

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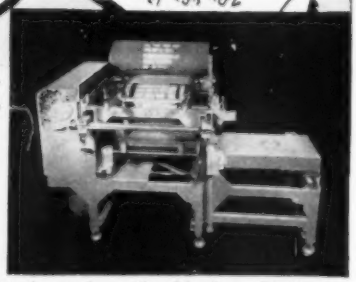

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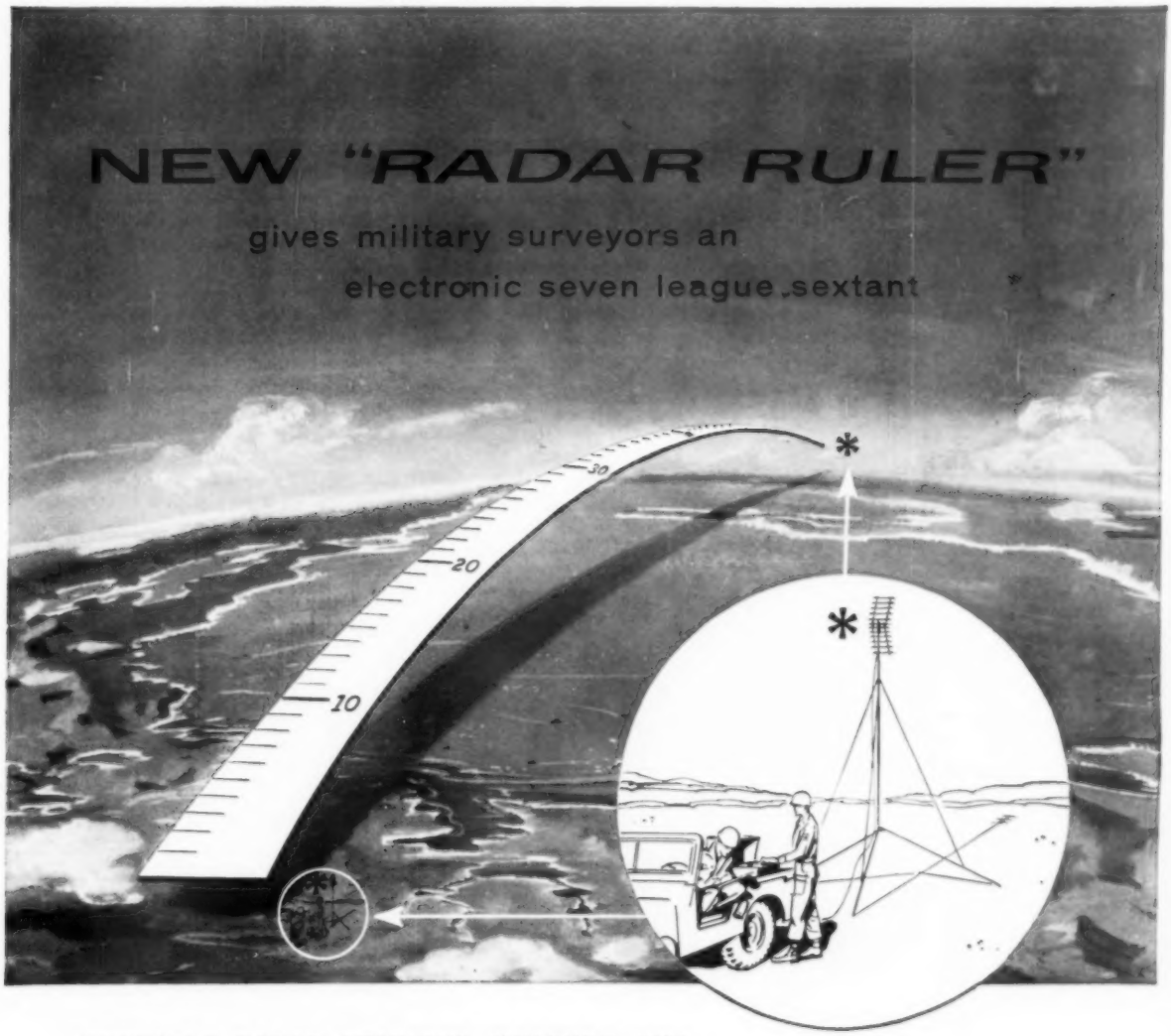
Members of New York Post Combine Fun And Ordnance At Picatinny Arsenal, N. Y.

The New York Post members were treated to an outstanding day of ordnance and recreational events by the Picatinny Arsenal on Tuesday, July 30th. Col. I. O. Drewry, commanding officer, greeted the members led by William L. O'Donovan, a director of the New York Post, acting in



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This new general-purpose surveying instrument was developed by Motorola's Military Electronics Laboratory for the Signal Corps Engineering Laboratories, Fort Monmouth, N. J. The entire operation can be handled easily and quickly by unskilled personnel.

This self-calibrating system uses two identical portable radar stations which bounce a signal back and forth thousands of times each second. High-speed computers automatically provide the data necessary to measure off the distance.

Here is just one more example of the equipment now being developed by Motorola for many varied military applications.

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behalf of Lieut. Gen. Leslie R. Groves, Post president.

Each member was presented with an excellent illustrated pamphlet describing the history and many activities at the arsenal. Picatinny was the prime source of know-how for the many establishments needed to expand into the production of explosives during World War II.

In a well-planned tour, visits were made to the rocket-test area, the 30-foot centrifuge, and the warhead and ammunition component development center. Each group was given a close-up view of artillery weapons in operation at the firing test site.

This meeting, attended by over four hundred members and guests was arranged by Col. Lloyd W. Stearns assisted by his program committee and the members of the District Ordnance Office.

• **BRIG. GENERAL URBAN NIBLO,** former Chief Ordnance Officer of the United Nations Command during the Korean war, died in Washington August 14, 1957. He was an ardent member of the Ordnance Association over many years. He retired from active duty in 1955 and had continued his A.O.A. interests with unabated vigor since then.

General Niblo was graduated from the United States Military Academy, West Point, in 1919. After serving in many assignments of great responsibility in the Ordnance Department of the Army, he became Ordnance Officer for the Fifth Army during the Second World War. His service in North Africa and in the Mediterranean Theater was outstanding. He was assigned to the Far East Command from 1946 to 1951.

Prior to his retirement from active military service he was deputy commandant of the Industrial College of the Armed Forces. After his retirement he became director of government operations for Dresser Industries of Dallas, Tex.

General Niblo was awarded the Distinguished Service Medal with Oak Leaf Cluster, the Silver Star, and the Legion of Merit. He also was awarded decorations from many foreign governments.

• **AUGUSTINE J. CUNNINGHAM,** long a member of the American Ordnance Association, died in Rochester, N. Y., on July 31, 1957.

Mr. Cunningham began work in the James Cunningham & Son plant, Rochester, in 1898, and in 1909, when the company was incorporated, became its first and only president. Under Mr. Cunningham's guidance the company pioneered early in the shift from the manufacture of horse-drawn carriages to automobiles.

It supported the armed forces in both World Wars. Between the wars, the company cooperated closely with Army Ordnance in light-tank development. In World War II it earned the Army Navy "E" for its production effort.

Recently, ever alert to changing times, Mr. Cunningham's company has been developing an electronic switch for television use. Mr. Cunningham was one of Rochester's most distinguished citizens.

• **BENJAMIN E. HARRIS,** vice-president and director of Ford, Bacon & Davis, and long a member of the American Ordnance Association, died at Suffern, N. Y., September 2, 1957. He was a leader in the design and construction of the Arkansas Ordnance Plant.

Mr. Harris was a graduate of Fordham University. He joined the engineering company in 1923 and was recognized as an authority on appraisals and evaluations of industrial and public-utility properties. He was in charge of many large projects in the fields of design and construction. After designing the Arkansas Ordnance Plant he later became general manager of the plant which Ford, Bacon & Davis operated under contract with Army Ordnance. Of late Mr. Harris had been supervising the company's engineering and economic studies in Pakistan.

• **G. STEWART CRANE,** nationally known industrialist, Milwaukee civic leader, and chairman of the board of directors of Cutler-Hammer, Inc., died in that city on September 28th.

Born in Port Huron, Mich., Mr. Crane joined the electrical firm in Milwaukee as a student engineer in 1910. Two years later he was transferred to the company's Pittsburgh district sales office and in 1916 was named manager of the Cleveland district sales office.

Mr. Crane returned to Milwaukee in 1921 to become manager of the firm's controller division. He successively served as general sales manager, vice-president in charge of sales, and vice-president in charge of sales and engineering before being elected president in 1945. He was elected chairman of the board of directors and chairman of the newly created plans committee in 1955, posts which he held at the time of his death.

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NEW DEVELOPMENTS

RADIATION DETECTORS

A new network of radiation detectors is being used in tanks, balloons, and underground by Army scientists during atomic tests to measure the amount of radiation following an atomic explosion.

Developed at the U. S. Army Signal Engineering Laboratories, Fort Monmouth, N. J., the new equipment keeps a continuous record of radiation hazards in the test area after a blast. The information is stored in well-protected underground recorders until the area can be entered safely.

One type of spotter being used is designed to pop up from the ground like a periscope to measure the radiation at various distances from the blast. A similar radiation probe has been installed in a Sherman tank, and a third set of instruments can be attached to a balloon tethered at 1,000 feet to measure radiation hazard in the air.

Results of these new tests may provide vital information on atomic battlefield tactics and for use by civil defense officials in planning against possible enemy nuclear attack.

PLASTIC CARTRIDGE CASE

Reduction in the weight of artillery ammunition is foreseen as the result of research and development tests with plastic cartridge cases, according to the Nonmetallic Materials Division, Chemistry Research Department of the Naval Ordnance Laboratory.

In firing tests with a 105-mm. howitzer the new plastic cartridge cases have shown themselves capable of withstanding gas pressures ranging from 6,000 to 35,000 pounds per square inch. At the instant of percussion the flame temperature inside the case is 2,400 degrees Kelvin.

Despite the sudden temperature and pressure changes, the cartridge cases emerge from the gun breech virtually unscathed. Many of them, in fact, could be used repeatedly.

The plastic material used in these cases is a special formulation developed for NOL by the Borg-Warner Corporation. This thermoplastic, a development of the past three years, is ideally adapted to mass-production techniques.

Weight reduction is the primary consideration in developing the new case, plus the fact that nonstrategic materials are used in its manufacture. The old standard brass case weighs 5.9 pounds, whereas the plastic case is only 2.5 pounds.

Total cost may not exceed $2.50 per case, delivered, after production costs are added. The case can be produced in almost any color desired, and it is possible that a color scheme could be established to designate different types of artillery rounds.

GIANT TREE CRUSHER

A huge machine that chews its way through a forest, rips trees up by the roots, slaps them to the ground, then literally smashes them into splinters has been built by R. G. LeTourneau, Inc., of Longview, Tex., and labeled the "Electric Tree Crusher."

Huge tree-clearing machine.

With this giant smasher it is believed that millions of new acres can be quickly and economically prepared for pastures, tree farming, reservoirs, or food crops from jungle and semijungle areas.

Length of the machine is 74.3 feet; width, 22 feet; height, 19 feet; roller diameter, 9 feet; roller base, 49 feet; fuel capacity 1,000 gallons; and weight is in excess of 140 tons. Extending from the rollers are more than 300 heavy steel cleats, each shaped much like a conventional ax blade.

When the machine is pitted against a large tree, a massive bar pushes the tree over. Then the machine's axlike teeth dig in and reduce much of the tree to splinters.

AERIAL GAS STATIONS

A high-powered radar beacon developed by the Air Research and Development Command makes it possible for fuel-hungry aircraft to rendezvous with flying tankers day or night or in any kind of weather.

Designated the AN/APN-69, the compact beacon was developed jointly by ARDC's Wright Air Development Center and the Sperry Gyroscope Company.

In air-to-air operations the beacon is installed in a designated rendezvous aircraft. Other aircraft wishing to "home" on the beacon from hundreds of miles away use interrogating radar to send out pulses of a specific type to trigger the beacon. In response to the proper interrogation signals, the beacon transmits a coded reply. The operator of the interrogating radar is thereby able to identify the beacon-equipped aircraft and determine its exact range and bearing.

ALL-SYNTHETIC TIRE

An all-synthetic, heavy-duty truck tire, with resulting independence from natural rubber imports, has been developed under Army Ordnance contract. The tire, made of butyl, a synthetic rubber created from oil refinery gases, has been perfected after three years of research by the Pennsylvania Tire Company, Mansfield, Ohio, and the Esso Research and Engineering Company, New York, N. Y.

The new tire is size 9.00 x 20, most widely used type in the Army. Ordnance tests, under cross-country and highway conditions, have shown butyl tires to be at least equivalent or superior to military tires presently being manufactured, and savings will result from the fact that the new tires do not deteriorate in storage.

MISSILE SQUADRON

The United States Air Force will activate the first Snark guided-missile squadron late this year. The squadron to be assigned to the Strategic Air Command will be equipped with the high-altitude, jet-propelled, intercontinental guided missile capable of delivering a nuclear warhead. The Snark, manufactured by Northrop Aircraft, Inc., is the first intercontinental missile to go into production for the Air Force.

Plans call for no missiles to be launched from operational sites except in case of war. For training purposes, missile crews will practice actual firing at an established range such as Patrick Air Force Base, Fla. The missile squadron will be manned by some 500 officers and men.

CONCENTRATED FUEL

Among the more promising propellants for use in rockets, hydrogen peroxide now is being produced in a higher concentration than formerly believed possible. The

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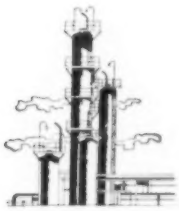

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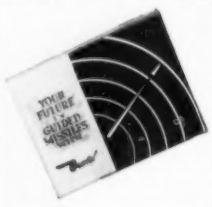

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first public description of the previously classified process was given at a meeting of the American Institute of Chemical Engineers at the Lord Baltimore Hotel, Baltimore, Md.

The new process produces a concentration of ninety-eight per cent hydrogen peroxide. The previous top concentration was ninety per cent. The additional eight per cent increases the performance of the fuel significantly. For example, there is a 25 per cent increase in horsepower per unit weight.

Up to now the compound has been produced only by a heat process. With the new procedure, crystals with ninety-eight per cent concentration of the compound are produced by freezing.

RADIATION PROOF CAB

A unique cab that protects a bulldozer operator from radiation has been developed by the Army Corps of Engineers. Made of lead and weighing approximately 5,000 pounds, the cab will allow Engineers to start early cleanup operations of radioactive areas created by a possible nuclear war.

The cab accommodates the operator, tractor controls, a radio, and special radiation meters that record the amount of radioactivity in the area. With a crane, three men can mount the cab on the tractor in thirty minutes. Lead-glass windows on four sides provide visibility for the operator. The cab is pressurized with fresh, filtered air.

HYPERVELOCITY GUN

A hypervelocity gun that fires midget missiles at 12,000 miles an hour has been developed at the Naval Ordnance Laboratory, Silver Spring, Md.

The 2-stage, gas-fired, 40-mm. gun is designed to perform basic aëroballistic research on missiles in the laboratory. Although not a weapon, the gun is able to fire a special nylon-sphere test projectile at a velocity over 18,000 feet a second. It is made of standard gun-steel alloy. The gun permits the simulation of the flight conditions of missiles.

The gun has two firing chambers that use a high-pressure hot gas mixture instead of conventional gunpowder to fire the projectile. Both chambers are filled with helium mixed with a volatile combination of hydrogen and oxygen under great pressure.

ELECTRONIC EXCHANGE

What is believed to be the world's first all-electronic telephone exchange for commerical use has been designed and built by a team of British engineers for Pye Telecommunications, Ltd., of England. This exchange is noiseless, impervious to

(Continued on p. 479)

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Many GPE Group products serve vital defense needs today. The scientific advances they embody will one day benefit everyone.

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"Portrait of The Future" is the well-chosen motto of this submarine. States U. S. Naval Institute Proceedings: "The *Albacore* will long be remembered as the pioneer design for flying under water." *Albacore's* revolutionary piloting technique was conceived and produced by Askania, a GPE company.

Link Aviation provides still another glimpse into the future with its F-11-F Flight Simulator in which pilots of the supersonic Tiger *pre-experience* flight conditions and maneuvers, "log" priceless familiarization time. Also "shipping out" with the Navy Air Arm is Kearfott, providing 400-cycle components for both planes and guided missiles.

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New Developments (Contd.)

damp or dirt, and has components that will last up to fifty years. There are no moving parts to go wrong.

The new exchange includes a memory which holds an incoming call until the number becomes disengaged, then puts it through. It takes less time to get the number required and uses less equipment to do it than a conventional exchange.

ARCTIC TRAINING

In line with the Army's responsibility to field mobile battle groups capable of fighting in all extremes of terrain and climate, the Continental Army Command has announced that it will be mandatory for at least 170 field-grade officers to attend its Cold Weather and Mountain School at Fort Greely, Alaska, during the next year.

Officers will normally be majors or above from the combat arms. Priority will be given to staff or faculty members of Army service schools or to those assigned to units scheduled to participate in forthcoming exercises in the Far North.

MOON USED AS RELAY

The moon can be used as a radio relay station. This is the conclusion reached by scientists at the Naval Research Laboratory after six years of experiments, using six different radar sets.

This scientific break-through is regarded as the most significant discovery made by radar.

The first experiments in 1951 involved sending pulses of electrical energy to the moon and back, using pulses only 10 microseconds long, supplied from a transmitter of one million watts' power, operating at a frequency of 200 megacycles. Continued experiments at the same and higher frequencies, which included round-trip transmission of voice messages, have confirmed this discovery and indicate that many types of communication can be carried on via the moon.

HIGH-STRENGTH ALLOY

A high-strength stainless-steel alloy that is said to permit airplanes to fly at four times the speed of sound without damage from the intense heat of air friction has been developed by Armco Steel Corporation. The new product retains great strength at temperatures up to 1,000 degrees Fahrenheit, a temperature generated at about 2,700 miles an hour.

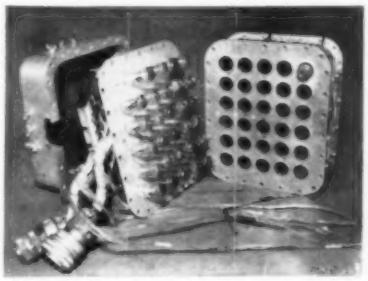
PLASTIC LIFEBOAT

A new type of lifeboat is to be constructed of laminated reënforced plastic and tested for use aboard American merchant ships, according to the Maritime Administration, U. S. Department of Commerce. These boats are expected to have a life span as long as the normal in-service use of the merchant ships to which they are applied, with little or no maintenance. Although such boats are in use abroad, this will be the first time that they have been built and tested for merchant marine use in this country.

Upon meeting performance tests by the U. S. Coast Guard, the first boats will be used on the WILLIAM PATTERSON, the Maritime Administration's experimental free-piston gas turbine Liberty ship, and on other Government-owned vessels in active service. Upon conclusion of successful tests and trials, such boats may be ordered on all new Maritime construction.

NEW COOLING SYSTEM

An airborne cooling system which will protect electronic equipment inside airplanes or missiles from the 800-degree-Fahrenheit temperature of Mach 5 flight has been developed by the Martin Company. The method is based on the high heat absorption quality of water. A can of water is mated mechanically to an electronic chassis. The water is vaporized by the external heat and released as steam. Internal heat generated by the electronic equipment is conducted directly into the boiling water.



Tubes are cooled by water jacket, right.

The results are essentially constant temperatures for the components despite aërodynamic heating conditions equivalent to those encountered at Mach 2 to 4.5.

The cooling effect can be maintained indefinitely depending on the amount of water employed. A quarter pint of water will cool a one-tube amplifier for fifteen minutes at Mach 4.5.

ACCURATE TIMING

When American scientists began tracking the Russian satellite they relied on the broadcasts of a little-know Government radio station for coordinated timing. The tracking stations used the time signals regularly broadcast by Station WWV at Beltsville, Md. Tracking teams will also use the WWV signals when the United States launches satellites of its own. In its everyday work, WWV helps keep the country's clocks on time, its musical instruments in tune, and its broadcast stations in their channels. The station and a twin (WWVH) in Hawaii are operated by the Boulder (Colo.) Laboratories of the National Bureau of Standards.

The demands of computer and control projects and problems over a 20-year period have earned for Librascope an enviable record of experience which is demonstrated by versatility and reliability in the design, development and manufacture of successful equipment. New demands of missile projects are reflected in Librascope's *profiles of experience.* This knowledge can be focused on *your* computer-control problems with the assurance of success. Librascope invites your inqury in this field. A letterhead request will bring you the Librascope story.

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MATERIALS PROGRESS

George S. Brady

The Growth of Plastics.—When the French scientist, Antoine Lavoisier (1743-1794), made his announcement that water was composed of hydrogen and oxygen, there was a furor among conservative scientists. It was not reasonable nor scientific that a liquid or a solid could be made out of a gas. An eminent Fellow of the Royal Society published an "exposé of the deception" in which he concluded sarcastically:

"This arch-magician so far imposes on our credulity as to persuade us that water, the most powerful antiphlogistic we possess, is a compound of two gases, one of which surpasses all other substances in its flammability."

Only as late as a quarter of a century ago, the head of one of our great engineering colleges went on record as saying that organic plastics could not be of general utility for mechanical parts. But last year more than 1,500,000 tons of plastics were consumed in the United States, not counting the plastic resins used for coatings and textile fibers.

Adding the weight of plasticizers and fillers which enter into the molding compounds, and judging on a weight-volume basis, the use of plastics for mechanical and electrical parts now far surpasses the combined consumption of copper and aluminum for those purposes. And, applying the famous phrase of Brig. Gen. Hugh Johnson, "You ain't seen nothing yet."

The consumption curve for plastics points steeply upward, and the Society for the Plastics Industry projects a consumption of 3,000,000 tons by 1960. The field of utility of plastics is being continually widened with new developments, many of which are not plastic but are nonreversible hard solids.

Silicon Compounds.—Plastics are essentially chain-linked molecular combinations of the gases hydrogen and oxygen and the plentiful carbon which, in the CO form, is a gas—all produced from abundant domestic raw materials. Textbooks published previous to World War II stated that "silicon lacks the power of forming long chains like those present in many carbon compounds. Because of this defect, although silicon is quadrivalent like carbon, a chemistry of silicon analogous to the chemistry of carbon is not possible."

However, during World War II, chemists in the laboratories of the *Dow Chemical Company* and the *General Electric Company*, who had forgotten or had ignored what they had learned in the college textbooks, developed silicon chain compounds, and a great group of "silicones," including rubbers and plastics of higher heat resistance, was commercialized.

The area of plastic research is now broadened, and combinations of these silicones with the carbon plastics are being made. A Dow disiloxane, called Syl-Kem 21, is being offered for copolymerization with styrene, acrylonitrile, or vinyl acetate. Plastics containing the gases chlorine and fluorine are also used for molded or extruded parts with superior chemical, electrical, and heat-resistant properties, and it is also projected that metal atoms may be incorporated in organic compounds to yield plastics of greater strength and heat resistance.

The Resin Race.—Last year the vinyl resins were far ahead of others in the quantity consumed, and styrene, a new resin during the war, was second in consumption. The phenolics, which may be considered as the first of the hard resins, have been increasing in use, but they are now low on the list in total consumption. Polyethylene, brought out in limited quantities during the war as a superior electrical resin, has now surpassed the phenolics and is particularly valued for pipe and tube making. Nylon, first famous as a material for ladies' hosiery, is now best known as a material for small gears, cams, mechanical parts, and electrical insulation, and its consumption as a molding plastic will double in the next five years.

Paraboloid Mirrors.—The development of quick-curing catalyzed epoxy resins has made possible the high-speed production of paraboloid mirrors by revolving a viscous resin on a parabolic pan. The smooth plastic surface is then metal plated, and the process eliminates the expensive labor of forming and polishing a metal mirror. The paraboloids are used for searchlights, headlights, light reflectors, and solar furnace reflectors. Large mirrors up to thirty-six inches in diameter are reënforced easily with impregnated glass fabric, and these large mirrors have

(*Continued on p. 484*)

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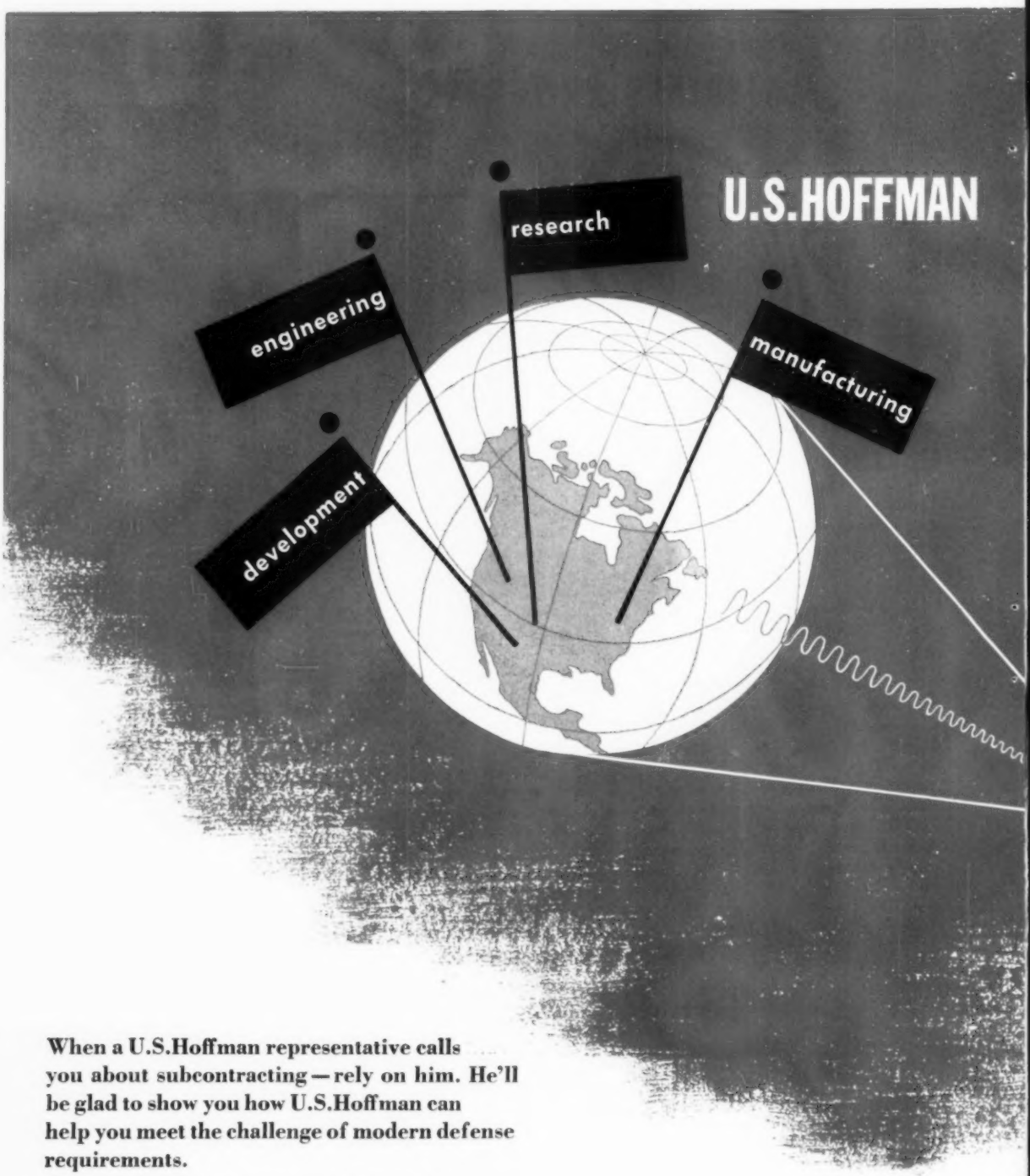

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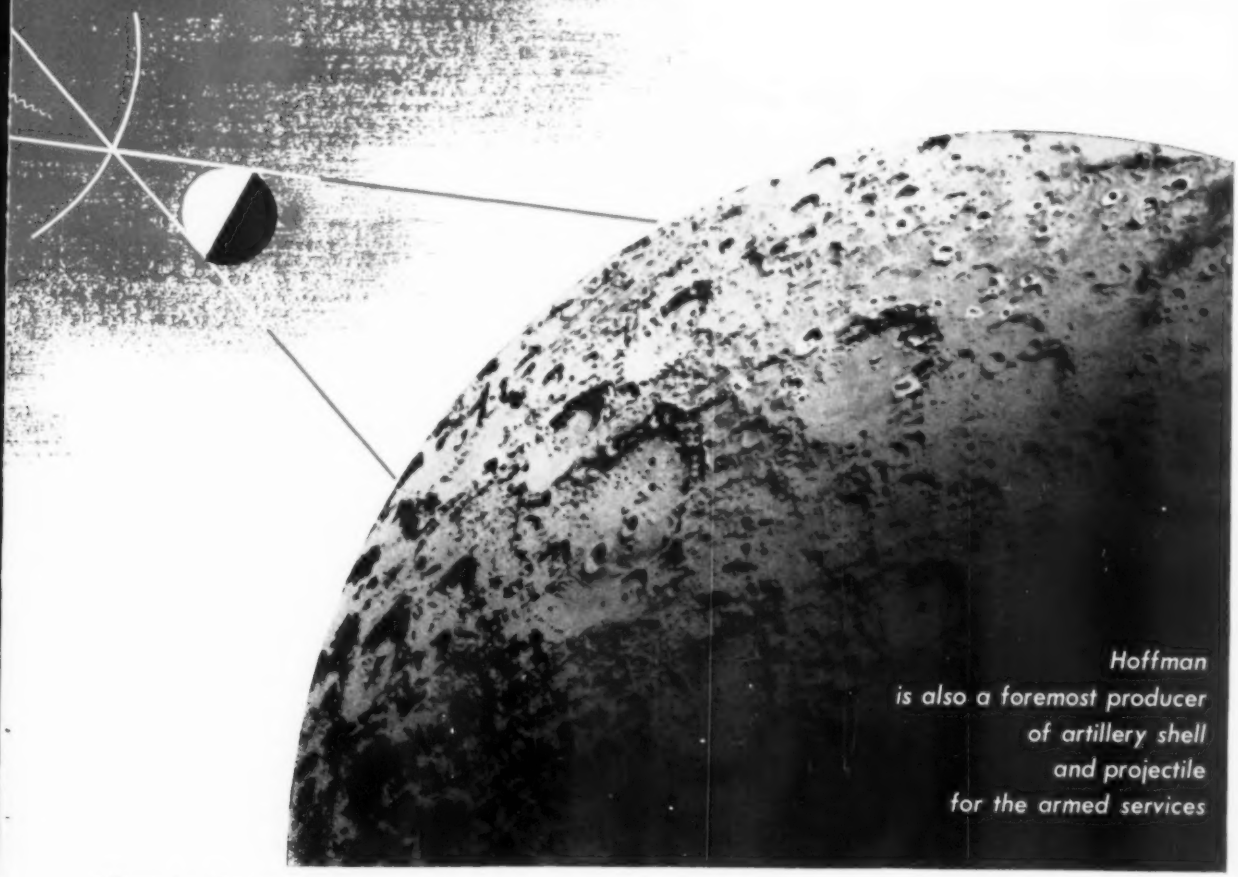

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Materials Progress (Contd.)

no more than twenty-five per cent the weight of a comparable metal mirror.

Polyethylene Pipe.—Since the war, steel companies have gone into the manufacture of plastic piping because of the obvious natural competition, especially for chemical processing and oil-field service where corrosion resistance would otherwise require the use of scarce and expensive alloying metals. Now, the *Evans Pipe Company*, Uhrichsville, Ohio, one of the oldest makers of clay pipe, has begun the production of polyethylene pipe in sizes from ½ to 6 inches for 75 pounds' working pressure for water, waste, and chemical plant service.

Miniature Parts.—Without plastics it would have been difficult to effect the miniaturization of electronic and electrical equipment as demanded by the Air Force and Signal Corps. Plastic parts so small that there are as many as 100,000 parts to the pound, with tolerances below 0.002-inch, and with no need for machining, are now made commercially by automatic injection molding. The *Gries Reproducer Corporation*, New Rochelle, N. Y., has been specializing in parts below a weight of 0.03-ounce. These include cams, gears, bobbins, fully threaded screws, and fastening devices.

Polycarbonate Resins.—Still in the research stage, but showing great promise, is a whole new family of polycarbonate resins characterized by a high impact strength, toughness, and dimensional stability at elevated temperatures not previously associated with thermoplastic resins. The resins differ from ordinary thermoplastics in having rhombic crystals that give a high density (specific gravity is 1.20). The molecular structure is in double-linked zigzag chains giving high rigidity. The polycarbonates are made by reaction of an emulsion of a polyphenol in methylene chloride, phosgene, caustic, and an ammonium hydroxide catalyst.

Carbonate Resins.—Under the name of Lexan, the *General Electric Company* recently has developed many different types and grades of carbonate resins with melting points as high as 250 degrees centigrade. One molded polycarbonate with melting point at 514 degrees Fahrenheit, has a flexural strength of 13,000 pounds per square inch and a Rockwell M hardness of 70. Its dielectric strength is 400 volts per mil. Carbonate plastic nails have been made that can be driven through plywood, a feature never before obtained in an organic material.

Aluminum in Autos.—The use of aluminum in passenger automobiles has been increasing, with an average of 92 pounds per car this year in Chrysler autos compared with 67 pounds per car last year. But the use of zinc die castings has also increased, with an average for all makes of 59 pounds per car this year—an increase of 8 per cent over last year. Zinc makes a low-cost part where weight is not important, where continuous impact is not too severe, and where plating is employed. The most frequently used zinc die-casting alloy employed today is ASTM XXIII, with 3.9 to 4.3 per cent aluminum, 0.03 to 0.06 magnesium, and 0.05 maximum copper. This alloy has good shock resistance.

Silicon Production.—The *Westinghouse Electric Company* now has a superpure silicon that is claimed to contain less than one part impurities in six billion of silicon and is capable of making resistors with up to four times the voltage and power possible with previous silicons. New techniques are by floating zone refining with induction heating and sweeping the impurities in one direction in a gas-tight enclosure. *Raytheon Manufacturing Company* also has a very pure silicon for use in infrared detectors for low-temperature target detection.

In a new facility in North Carolina, *Du Pont* will produce 50,000 pounds annually of semiconductor-grade silicon, and 20,000 pounds of solar-battery grade. Several other companies have planned increased production, while selenium, recently a shortage material, is now in oversupply. The confidence in the future of the silicon market indicates the trend. Transistors now represent probably no more than five per cent of the quantity of vacuum tubes made, but space saving alone will be sufficient incentive for the turn to silicon. In rectifiers, heat resistance as compared with selenium is even more important than space and weight saving. Color users are happy with the released pressure on the selenium market. Incidentally, the *Baker & Adamson General Chemical Division*, Allied Chemical & Dye Corporation, is now producing a technical grade of selenium as a by-product in the manufacture of sulphuric acid from pyrites.

Tin Production.—While African, Malayan, and Thailand tin output has increased in 1957, estimates indicate that tin production now exceeds consumption. Surveys on Malayan tin indicate that unmined resources are as great as all the tin taken out of Malaya to date. The United States buys about half of all world tin, and a large proportion of it has been used for coating steel; about 42 billion cans were produced in the United States last year. An eventual shift to aluminum is projected for some types of cans, but the greatest immediate saving in tin is expected from the widening use of the Hinac process of coating blackplate steel for can making. *(Continued on p. 486)*

R

RAPID

RACE* eliminates slow, time-consuming manual tests by electronically checking complete weapon system such as missile or aircraft. Operating on initial assumption that system is functioning properly, RACE speeds through primary test of over-all system or major sub-systems. If fault exists, RACE signals "no-go", then isolates fault through secondary tests. Complete job is done in only minutes.

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E

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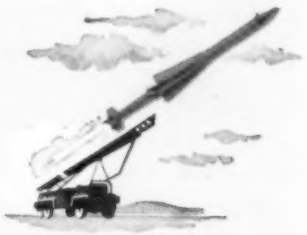

1030 HOURS

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Materials Progress (Contd.)

Steel Coating.—The Hinac process, developed by the *Heintz Manufacturing Company*, Philadelphia, Pa., together with the *American Can Company* and the *Bethlehem Steel Corporation*, is a continuous chemical method which electrolytically cleans, acid etches, dip coats, and passes the sheet through a bake oven. The coating consists of an inorganic chromate compound which is highly adhesive, scratch resistant, and corrosion resistant. The production of coated steel from the first line installed has been used successfully for detergent cans where alkaline attack is predominant. Since the coating gives superior adhesion for enamels, enameled cans with the Hinac base will be superior and less costly than those with a thin tin base plate.

Aluminum Pulleys.—A German firm, *Heinrich Desch, GmbH*, is producing V-belt pulleys with an aluminum body cast around a cast-iron core. To maintain the machined accuracy of the core, the iron is chilled during the casting cycle. The only machine work then needed is the removal of the fins.

Magnesium Ramp.—An all-magnesium construction is used in the new yard-type car loading ramps of 3 to 8 tons' capacity designed by the *Lite-Line Industries Division*, Copperloy Corporation, Cleveland, Ohio. The ramps, which can be moved into position by one man, are 30 feet long and 60 and 70 inches wide, have bridge-type girders, and 16-inch tired wheels in the center.

New Aluminum Alloy.—The *Apex Smelting Company*, Chicago, Ill., has developed a new aluminum casting alloy, Apex 417, that gives free-machining castings of high strength, good corrosion resistance, and dimensional stability. The alloy contains 6.5 to 7.5 per cent magnesium, 0.10 to 0.25 per cent each of titanium and manganese, 0.10 maximum copper, 0.15 maximum silicon, 0.20 maximum iron, 0.05 maximum zinc, and the balance aluminum. The tensile strength of the cast metal is 40,000 pounds per square inch, yield strength 21,000 pounds per square inch, elongation 13 per cent, and Brinell hardness 70.

Aluminum Powder.—The accumulation of a hard oxide on aluminum exposed to the atmosphere has been considered as an impediment to the production of aluminum powder metallurgy products. But *Aluminum Company of America* now has utilized this characteristic of aluminum to produce sintered metal which retains high strength at elevated temperatures. When fine unalloyed aluminum powder, with each flake coated with aluminum oxide, is compacted into impact extru-

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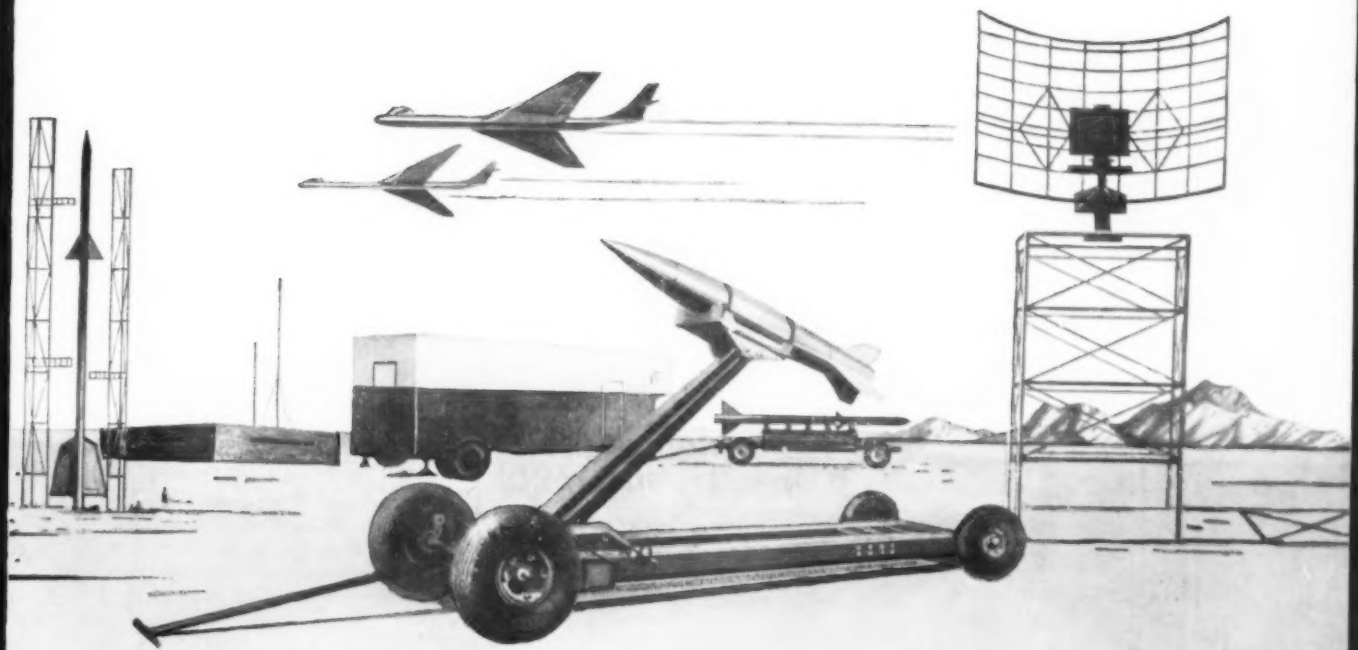

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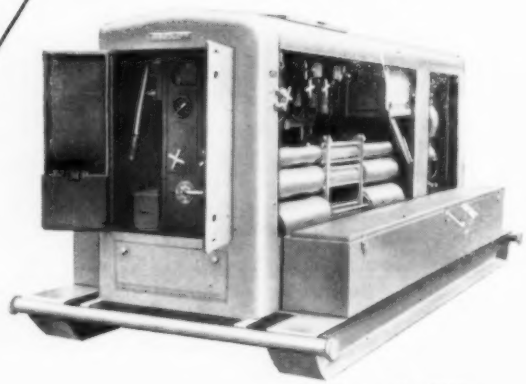

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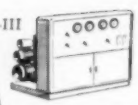

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sions, extruded shapes, or forgings, the metal has increased strength and will resist temperatures to 900 degrees Fahrenheit—more than 300 degrees higher than the limits of conventional aluminum or alloys. The company claims that aluminum parts made by powder metallurgy can replace titanium parts at lower cost for some uses where aluminum was formerly not considered satisfactory.

High-strength Steels.—Engineers of the *International Nickel Company* predict that alloy structural steels with a tensile strength of 300,000 pounds per square inch will be available commercially in the near future without the use of excessive amounts of strategic alloying elements. They base the statement on the results of research into control of hydrogen embrittlement, addition of silicon which allows higher tempering heats and raises the yield strength, and on controlled balances of titanium with lowered carbon and increased molybdenum and vanadium.

New Alloys.—The *Haynes Stellite Company*, Kokomo, Ind., has a new alloy, Hastelloy R-235, in which strength retention at high temperatures has been attained with an aluminum-titanium-nickel compound in the structure. This alloy is not a steel, however, as it contains only 10 per cent iron and 2.5 cobalt. It also contains about 15.5 per cent chromium, 5.5 molybdenum, and 1 per cent each of silicon and manganese. It has 2.5 per cent titanium and 2 aluminum, with the balance nickel, and the high-temperature strength is derived from the formation of the compound Ni_3Al.

When the alloy is heated to 2,150 degrees Fahrenheit and air cooled, part of the aluminum is replaced by titanium to form the compound $Ni_3(Al, Ti)$ with no change in phase. At ordinary temperatures the tensile strength is about 167,000 pounds per square inch, and at a temperature of 1,500 degrees the tensile strength is still above 90,000 pounds per square inch. At about 1,800 degrees the strength drops to 22,000 pounds per square inch.

Ceramic Cutting Tools.—The Russians have claimed great success in the use of ceramic cutting tools to replace high-speed steels and the more expensive sintered carbides. However, the Russian "Microlite" is definitely an aluminum oxide with a binder, and American experience with the brittle aluminum oxide does not indicate that it is the solution for cutting tools. *Ohio State University* has been conducting tests of ceramic cutting tools, sponsored by the *Warner & Swasey Company*, and *Watertown Arsenal* also has been testing such tools.

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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Aërodynamics.—The Defense Department recently officially revealed that the Lockheed X-17 hypersonic test vehicle had reached the highest speed attained by any instrumented missile. Actual figures have not been released, but figures of 9,000 to 9,300 miles an hour have been reported.

The NACA is currently testing two unusual wing configurations—the M and W configurations. The M wing is swept forward near the fuselage and back at the tips. The W wing is just the opposite. The M-type wing is superior to the conventional swept wing both from the standpoint of stability and aëroelasticity. Use is seen in supersonic heavy transports, bombers, and missiles. Tests have been made at speeds up to Mach 1.4 by means of rockets.

Astronautics.—Latest word on the Vanguard satellite project is that a launching will take place during the International Geophysical Year. In the test program, burnouts were experienced on the first- and second-stage rocket engines. Moreover, vibration problems also were uncovered. Two test vehicles already have been fired in the program. It is now estimated that the satellite project will cost at least $110 million.

Another rocket group, the Aerojet-General Corporation of Azusa, Calif., has formed a research program for astronautics. A propulsion section will investigate ultra-energy chemicals, free radicals, ion jets, and nuclear propellants. Development of new materials for very high and very low temperature use also will be studied. The new propellants and materials will be viewed for applications in extraterrestrial vehicles. An astrophysical section also has been formed, and it will be concerned with magnetics, extraterrestrial matter, and environmental conditions.

Missiles.—More activity has been reported in the ballistic missiles program. The Army announced that it had successfully fired its *Jupiter* IRBM. A few days later, the Air Force revealed that it had launched a *Thor* IRBM. The *Thor*, however, did not achieve its full 1,500-mile range because of a mechanical failure during flight. There are conflicting reports about our *Atlas* ICBM progress. Florida sources say that an *Atlas* already has been flight tested. The official word, however, is that the program is well under way and that flight tests may be expected in the near future.

Three long-range-missile contracts have been awarded by the Air Force. General Electric Company, Philadelphia, Pa., gets $158 million for *Thor* and *Atlas* nose-cone development. Avco Manufacturing Corporation, Lawrence, Mass., will work on a $111 million development program for *Titan* nose cones. The Northrop *Snark* SM-62 intercontinental cruise missile will be produced on a $73 million order. The other long-range cruise missile, the *Navaho*, will be dropped as an interim weapon.

Increased mobility is now possible for the Army's *Corporal* rocket. An all-terrain vehicle serves as a transporter and launcher. The vehicle is Diesel-electric and is already in operation by U. S. units. An undisclosed number of the launchers is also to be built for the British Government.

The Army *Hawk* missile, designed to defend against low-altitude targets, is going into operation. Two sites—New York and Washington, D. C.—are being readied for the weapon which is designed to supplement the *Nike*.

The *Zuni* is a Navy replacement for World War II aircraft rockets. The 5-inch *Zuni* is 110 inches long and weighs 107 pounds. The folding-fin rocket is propelled by a solid-propellant charge. Speed is near Mach 3. Developed at the U. S. Naval Ordnance Test Station, China Lake, Calif., the rocket is said to cost about $150 a round. Other Navy air missiles include: *Sidewinder*, a heat-seeking air-to-air rocket; *Corvus*, an air-to-surface missile to be used on carrier-based aircraft; *Diamondback*, a potential successor to *Sidewinder*; and the *Bullpup* an air-to-surface solid-propellant rocket.

The U.S.A.F. has fired its first atomic air-to-air rocket, the *Genie*. Launched from an F-89J interceptor, the missile was detonated at an altitude of 18,000 feet over the Yucca Flat test site. The MB-1 warhead for *Genie* was first tested in 1955 in an air-drop test. Other planes which may be able to carry the atomic missile are the F-101, F-102A, and the F-106.

A new *Falcon*, the GAR-2A, has been unveiled by the Air Force. The air-to-air rocket is guided by infrared radiation given off by the target. Range is about five miles after launch. Cost is about

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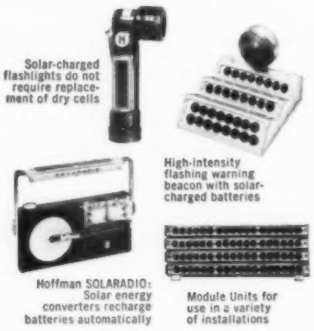
Solar-charged flashlights do not require replacement of dry cells
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Hoffman SOLARADIO: Solar energy converters recharge batteries automatically
Module Units for use in a variety of installations

Some of these products are already on the market—others are still undergoing intensive tests and evaluation in the field. If you have applications for which Hoffman solar converters might be used to advantage, you are invited to write for additional information.

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Rockets and Missiles (Contd.)

$9,000 each. The GAR-2A and its radar-guided cousin, GAR-1D, has a kill probability of 80 to 90 per cent in mixed firings. The new missile has been fired from the F-89H, F-101B, and the F-102A. It is expected that both types of missiles will be carried aloft with the pilot deciding which missile to use. The two missiles are identical with the exception of the guidance nose.

Other Air Force air missiles under development are: *Green Quail*, an air-to-surface decoy missile; *Duck*, an air-to-air bomber defense rocket; *Goose*, an air-to-air decoy missile. Two other bomber-defense missiles are the *WS-126A* and the *WS-132A*.

Research.—The first rocket firings in the IGY program were made at the Navy's Point Mugu installation. The first of fourteen *Dan* rockets (*Nike-Ajax* booster plus *Deacon* sustainer rocket) were fired. This phase of the program will correlate radio fade-out with solar flares. The entire program is set up for fast operation since it takes about one minute to tell if a flare is beginning. A solar flare may hit its peak in about five minutes. It now takes about three minutes to set up and fire a rocket, but the hope is that eventually the time can be cut to one minute.

A combination balloon-rocket is to be launched from Eniwetok Atoll. The aim is to reach an altitude of 4,000 miles. Called Project Far Side, the balloon will carry aloft a multistage rocket to an altitude of 100,000 feet. A 4-stage rocket will be used to attain a top speed of about 25,000 feet a second. The Air Force Office of Scientific Research is sponsoring the project and Aeronutronic Systems, Inc., Glendale, Calif., is the prime contractor. The balloon is being built by General Mills, Inc. The University of Maryland is designing the instrument payload.

The first-stage rocket uses four Thiokol *Recruits*, second stage is one *Recruit*, third stage is four *Asps*, and the fourth stage is a single *Asp*. Six shots are being scheduled—with the first firing expected this fall. Purpose of the project will be to gather data on cosmic rays, magnetic and gravitational fields, ion studies, and meteorite density.

Another program for high-altitude investigation has been proposed by Stanford Research Institute, Menlo Park, Calif. In this system a solid-propellant rocket carries a parachute sonde to an altitude of 150,000 feet. Here the instrument is released and tracked by an AN/GMD-2 rawinsonde which also picks up data. The study was made for the Federal Civil Defense Administration. FCDA would need such high-altitude data for predicting atomic fallout.

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ARMAMENT ELECTRONICS

W. H. Van Vliet

"Solion," New Electronic Marvel.—The Naval Ordnance Laboratory in Washington has announced an electrochemical device which may rival the vacuum tube and transistor as a basic component in the electronic inventory. The device uses the movement of ions (electrically charged atoms or molecules) in a solution instead of in a gas or vacuum, as in a tube, or in a solid, as in a transistor. In the case of the "solion," the electrons flow between electrodes in an iodine solution.

The solion is expected to have solid impact on the electronic industry. It is anticipated that the device's most important use will be in the area of guidance and navigation. The solion is highly sensitive to changes in outside conditions; for example, the electrical flow of ions can be stimulated and varied by changes in temperature, pressure, light, sound, or accelerations in any axis. The solion can reduce the size of present electronic guidance systems, according to recent reports, and in certain applications it promises to do certain jobs better than the vacuum tube or the relatively recent transistor.

Flat Cathode Ray Tube.—The Office of Naval Research has released information on a radically new aircraft cockpit display. According to Rear Adm. Rawson Bennett, a flat cathode ray tube for presentation of information to pilots has been developed by Kaiser. The cockpit display is scheduled to undergo flight evaluation later this year.

A Forward Look.—Electronics industry leaders are beginning to take a long look into the future in endeavoring to establish planning programs. The length of the look is a matter of opinion at this time. Ralph J. Cordiner, president of General Electric Company, suggests 15 to 20 years. On the other hand, Robert C. Tait, president of Stromberg-Carlson Company, thinks 5 years is a minimum and that 10 years is too long. Don G. Mitchell, president of Sylvania Electric Products, Inc., cautions against overplanning to the detriment of production. However, the consensus of the electronics industry indicates that long-range planning is a very essential tool of management. Its most highly developed form includes all phases of the functioning industrial areas. Most advocates of long-range planning feel it is as essential to the small firm as to the large.

Kilowatt Transistors.—A new Westinghouse technique, evaporating aluminum into slots milled in germanium wafers to form emitter and collector junctions in transistor construction, appears very promising. This process makes possible the production of junction transistors approaching the kilowatt range and controlling up to ten amperes. Current gains over 100 are easily attained.

Polaroid Prints Via FAX.—The Army Signal Corps Laboratory unveiled facsimile equipment which handles 3¼ by 4¼-inch Polaroid prints and can be operated in the back of a jeep. The operator merely pushes a print into a slot and flips a switch. A photo with a 200-line-per-inch resolution pops out of a facsimile receiving unit miles away about five minutes after the photographer takes the original picture. This includes one minute at each end for the processing of the Polaroid film. The Navy and Air Force are interested in the program but are awaiting further studies to determine full military applicability.

Keep It Simple.—Lieut. Gen. C. S. Irvine, Deputy Chief of Staff for Matériel, U. S. Air Force, stated at a recent national convention on military electronics: "Electronic products have to be more efficient and far simpler from the maintenance point of view than anything yet offered. And they have to come faster than in the past." Specific recommendations were: "Strive for greater simplicity. Improve the critically serious problems of reliability and efficiency of operation. Ruggedize marginal components. Eliminate after-manufacture adjustments. Improve systems engineering. Achieve better management. Develop components for reliable operation at high altitudes and at speeds of Mach 10."

General Irvine feels that the fear of having or designing equipment that has limited civilian use has delayed development in some fields. He pointed out that advanced circuits and systems would have wide commercial applications and would be profitable to industry.

Radar Hazard.—A recent report in *California Medicine* clearly points out the hazard of energy radiated from a radar antenna. A radar technician was caught in the beam of a powerful radar antenna at

TYPICAL CORROSION RESISTANCES OF ZICRONIUM AND TITANIUM

CORROSIVE MEDIA	METAL RESISTANCE	
	ZIRCONIUM	TITANIUM
Sulfuric Acid	excellent to good below 80%	good below 5%
Nitric Acid	excellent	excellent
Hydrochloric Acid	excellent	good below 10%
Phosphoric Acid	excellent to fair below 85%	poor
Chromic Acid	excellent	excellent to good
Aqua Regia	poor	excellent
Wet Chlorine Gas	poor	excellent
Chlorine Water	excellent	excellent
Sodium Hydroxide	good below 90%	good below 50%
Ferric Chloride	poor	excellent
Calcium Chloride	excellent	excellent
Cupric Chloride	poor	excellent
Sodium Chloride	excellent	excellent
Ammonium Chloride	excellent	excellent
Aluminum Chloride	excellent	excellent to fair

Corrosion resistances of zirconium and titanium to typical chemicals are shown above.

At right is a steam jet made of zirconium which has given trouble-free performance after a year in hydrochloric acid service. For comparison, a throat piece from a steam jet made of cast iron is shown after only a week of similar service.

ZIRCONIUM AND TITANIUM LICK TOUGHEST EQUIPMENT CORROSION PROBLEMS

The use of zirconium, titanium, or alloys of these metals now makes it possible to fabricate equipment that is corrosion-resistant to almost every substance encountered in industry. Even with such difficult-to-handle chemicals as chlorides and oxidizing acids, equipment can have extremely long service life. Problems of product contamination in chemical and food processing can be virtually eliminated.

Costs are cut in two ways. Direct maintenance costs are lowered, but even more important, costly downtime for the replacement of equipment can be avoided. These savings can more than compensate for the relatively high initial investment.

At the moment, equipment can be fabricated from titanium for about twice the price of stainless steel with even lower costs anticipated in the near future. When volume production is reached, commercial grade zirconium will probably cost only 50 to 75% more than stainless steel.

Wider application of these metals at reasonable cost is made possible by increased production and improved techniques provided by new U.S.I. facilities. By the end of this year, U.S.I.'s new titanium plant will add 5,000 tons to the nation's annual output. The new U.S.I. zirconium plant at Ashtabula, Ohio, employing a sodium-reduction process, will be able to supply 1,000,000 pounds of zirconium platelets to industry in 1958, in addition to meeting Atomic Energy Commission commitments.

If you have a corrosion problem, it will pay you to investigate the advantages of using these new metals. For more information, write to Bill Greenleaf, Manager of Metals Development.

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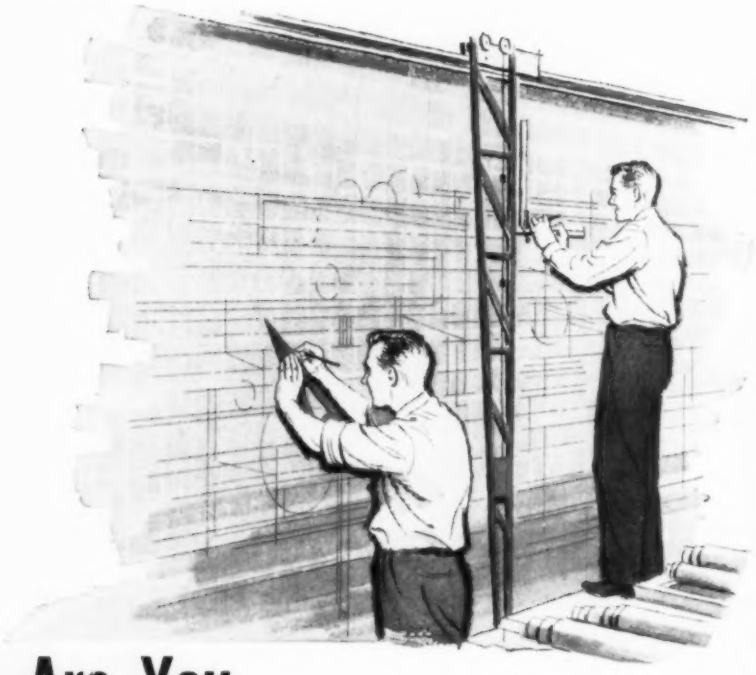

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Armament Electronics (Contd.)

a distance of about ten feet. In a few seconds he felt internal heat. The heat became intolerable within a minute and he moved away. Within half an hour he had acute abdominal pain and became nauseated. The technician, in spite of adequate medical care, died within twelve days.

Human tolerance to radiant power is lowest in the S and C bands (about 3,000 and 5,000 mc) where energy is dissipated as heat a few centimeters below the skin. Organs with little blood-cooling ability, such as the eye, gall bladder, and urinary tract are susceptible to irreversible damage. One report indicates that the dangerous power level is about 3 watts (average) per square centimeter. Another states 0.01-watt per square centimeter as a recommended tolerance level. The latter probably is concerned with cumulative effects on the eye. The technician in this case was believed to have been exposed to about 2.5 megawatts, about 25 to 50 watts per square centimeter. Radiation to flesh and muscle is not so hazardous because of the cooling action of the blood.

Navy Computer.—A $3½ million Univac-Larc general-purpose electronic digital computer was ordered recently by the Bureau of Ships for delivery to the David Taylor Model Basin sometime during the latter part of next year. The Applied Mathematics Laboratory will use Larc to solve design and shipboard problems associated with the installation of nuclear reactors.

Design Reliability.—The U. S. Air Force has engaged RCA to determine standards for design and reliability of airborne electronic equipment. Three phases are involved in the program. Specifically, RCA will establish and develop:

1. Uniform standards for design of future airborne communication, navigation, and identification systems. The objective is to reduce repackaging and redesigning now required to fit present equipment to specific weapons systems.
2. A means by which the reliability of an electronic system can be determined numerically.
3. An improved airborne UHF voice communications system, probably an advanced version of the ARC-34.

Weather Rockets.—Electronic gear for passing weather information from high altitudes may ride rockets instead of the more conventional weather balloon. The Naval Ordnance Laboratory has fired a 6-pound warhead of electronic weather gear some 60 miles into the blue. The Hasp (high-altitude sounding projectile) is fired from a 5-inch rifle and has successfully reached 110,000 feet. The Navy expects to add another 200,000 feet to the present record sometime in the future.

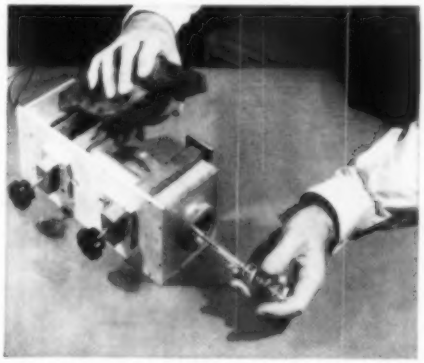
A GREAT AMPLIFIER TUBE IS PERFECTED FOR TELEPHONY

A new transcontinental microwave system capable of carrying four times as much information as any previous microwave system is under development at Bell Laboratories. A master key to this development is a new traveling-wave tube of large frequency bandwidth.

The traveling-wave amplifying principle was discovered in England by Dr. Rudolf Kompfner, who is now at Bell Laboratories; the fundamental theory was largely developed by Labs scientist Dr. John Pierce. Subsequently the tube has been utilized in various ways both here and abroad. At the Laboratories it has been perfected to meet the exacting performance standards of long distance telephony. And now for the first time a traveling-wave tube will go into large-scale production for use in our nation's telephone systems.

The new amplifier's tremendous bandwidth greatly simplifies the practical problem of operating and maintaining microwave communications. For example, in the proposed transcontinental system, as many as 16 different one-way radio channels will be used to transmit a capacity load of more than 11,000 conversations or 12 television programs and 2500 conversations. Formerly it would have been necessary to tune several amplifier tubes to match each channel. In contrast, a single traveling-wave tube can supply all the amplification needed for a channel. Tubes can be interchanged with only very minor adjustments.

The new amplifier is another example of how Bell Laboratories research creates new devices and new systems for telephony.



Left: A traveling-wave tube. *Right:* Tube being placed in position between the permanent magnets which focus the electron beam. The tube supplies uniform and distortionless amplification of FM signals over a 500 Mc band. It will be used to deliver an output of five watts.

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RECENT PATENTS

This department on recent military-industrial patents is being published in ORDNANCE *to keep our readers informed of the latest developments in these fields. The data are compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.*

Recoilless Artillery Weapon.—*U. S. Patent No. 2,789,471. Issued April 23, 1957, to Guion S. Bluford and Clarence W. Musser. Assigned to the Secretary of Defense:* The object of this invention is to provide exceptionally lightweight recoilless

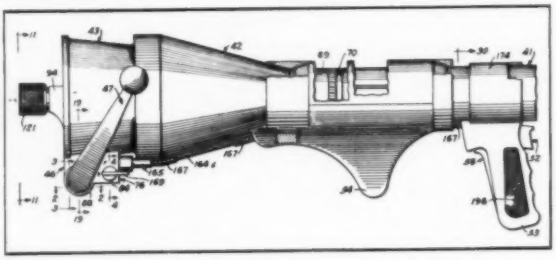

Fig. 1. Drawing of lightweight recoilless 57-mm. gun.

guns in which the forces of rearward reaction that result from a projectile's discharge are neutralized by forwardly acting counterforces simultaneously set up by a rearward escape of propellent powder gases through openings or orifices in the gun's breech. Figure 1 shows a recoilless gun of 57-mm. caliber incorporating the features of the invention.

Gun Installation in Jet Aircraft.—*U. S. Patent No. 2,787,194. Issued April 2, 1957, to Paul F. Peterson. Assigned to North American Aviation, Inc.:* This invention provides a gun installation in a jet aircraft which avoids compressor stall or flameout of the engine when a gun is fired at high altitude and low Mach number. A baffle arrangement is disposed forwardly of the gun muzzle, preventing the gases from entering the engine air intake so as to cause these effects.

Incendiary Munition.—*U. S. Patent No. 2,787,217. Issued April 2, 1957, to Oscar B. Mahaffie. Assigned to the Secretary of the Army:* This invention provides a single incendiary munition which upon actuation separates into two independent incendiaries, one consisting of a mass of burning jellied gasoline and the other an incendiary bomb with the ability to "seek" a target.

Repeating Rocket Launcher.—*U. S. Patent No. 2,787,192. Issued April 2, 1957, to Stephen A. Stam. Assigned to the Secretary of the Army:* A loading mechanism for a semiautomatic repeating type of rocket launcher is described which effects a very great saving in time if it becomes necessary in an emergency for the gunner to take over loading the launcher. Saving in time also may be accomplished by the gunner taking over loading while the loader is refilling the magazine. The loading means may be operated from either side of the launcher by separate loading levers.

(Continued on p. 500)

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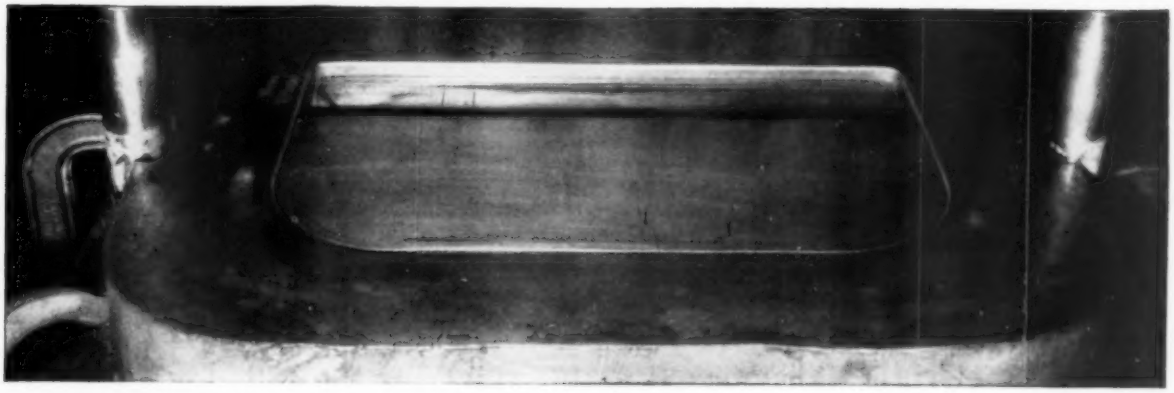

Ductile Cast Iron Die (flame-hardened) used to draw and form stainless steel sheets for inside and outside parts of milk and cream dispensers. Its strength and toughness give it good die characteristics. "Built-in-lubrication" – supplied by spheroids of graphite – resists galling and pickup, keeps critical surfaces smooth and blemish-free. Dies cast by Prospect Foundry Company for Norris Dispensers, Inc., Minneapolis, Minn. For full particulars on the use of Ductile Cast Iron for stamping and drawing carbon steel, stainless steel or aluminum, just write us.

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Recent Patents (Contd.)

Smoke Projectile.—*U. S. Patent No. 2,789,467. Issued April 23, 1957, to Henry Rosenthal. Assigned to the Secretary of the Army:* This invention provides a smoke projectile to provide smoke cover for a combat vehicle. Previous smoke grenades developed to provide a quick "getaway" for combat vehicles and to ensure sufficient smoke protection during maneuvering were found to be inadequate for screening purposes due to excessive time required for the projectile to produce the desired volume of smoke. The present projectile establishes an effective smoke screen within a very short time interval after initiation of the charge.

Mine Mooring Device.—*U. S. Patent No. 2,789,503. Issued April 23, 1957, to James B. Glennon, Chester M. Van Atta, and Joseph D. Turlay:* This invention describes a method of mooring a submarine mine in which the stability of the mine is increased and the oscillatory or rocking movement as the result of tidal currents is reduced. The mine is adapted to be moored at a predetermined depth of submersion within the water. It is provided with an arm projecting radially outward, to which the mooring cable is secured, thus preventing rocking motion of the mine.

Means also are provided for releasing the mooring arm from the cable in response to the approach of a vessel within the vicinity of the mine, thereby allowing the mine to rise within the water and explode sufficiently close to the vessel to damage or destroy it.

Liquid Propellant Rocket.—*U. S. Patent No. 2,789,505. Issued April 23, 1957, to James M. Cumming, George P. Sutton, Vernon R. Vorzcerk, Darell B. Harmon, and Charles A. Villiers. Assigned to North American Aviation, Inc.:* This invention provides a liquid-propelled rocket of maximum total impulse-to-weight ratio in which the potential energy of the propellants is partially released to provide pressurization of the rocket in order to force the propellant into the combustion chamber.

Reactor Refueler.—*U. S. Patent No. 2,794,562. Issued June 4, 1957, to G. A. Anderson:* This patent relates to a device for remotely refueling a gas-cooled reactor without loss of the high-pressure gas. A rotating magazine containing the fuel elements is positioned against the core of the reactor, rotated to align the cartridges with the desired tubes, and a remotely controlled plunger arrangement inserts the fuel elements into the reactor channels. This charging apparatus simplifies the refueling of a gas-cooled reactor.

Neutron Ion Chamber.—*U. S. Patent No. 2,795,704. Issued June 11, 1957, to H. Bryant et al.:* This patent pertains to a device for measuring neutron flux density in a radiation field which is composed of neutron and gamma radiations. The device comprises an ionization chamber having a pair of electrodes, a movable element within the chamber, a portion of the element responsive to neutron bombardment to produce ionization, means to impress a potential between the element and each of the electrodes, means for moving the neutron-responsive portion of the movable element past the electrodes to vary the ionization between the element and each of the electrodes, and means for detecting the variation in potential. An AC current with its amplitude proportional to the neutron density is created by this device.

Solvent Extraction Process.—*U. S. Patent No. 2,796,320. Issued June 18, 1957, to F. H. Spedding and A. Kant:* This patent relates to the separation and purification of thorium. This purification can be made by extracting an aqueous thorium salt solution by means of a liquid organic solvent. Satisfactory organic solvents include ethers, esters, ketones, alcohols, and alkyl phosphates. The extraction process also calls for the use of very water soluble nitrate or chloride as a salting-out agent.

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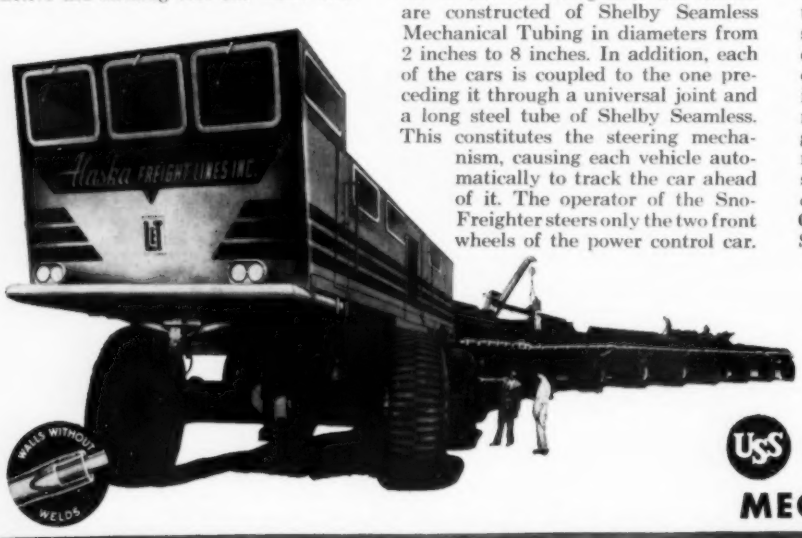
The LeTourneau Sno-Freighter is a huge six-section cargo carrier specifically designed to travel over ice, frozen or compacted snow, bull-dozed trails, or rough brush land. It is presently in active use hauling fuel and other strategic materials to radar stations along the Arctic Coast.

The Sno-Freighter "train" consists of a power control car and five cargo cars, each with a capacity of 25 tons. All of the Sno-Freighter's car frames are constructed of Shelby Seamless Mechanical Tubing in diameters from 2 inches to 8 inches. In addition, each of the cars is coupled to the one preceding it through a universal joint and a long steel tube of Shelby Seamless. This constitutes the steering mechanism, causing each vehicle automatically to track the car ahead of it. The operator of the Sno-Freighter steers only the two front wheels of the power control car.



There are many good reasons why Shelby Seamless Mechanical Tubing was chosen for the supporting framework of this magnificent mechanical marvel. Primarily, it offers the ultimate in strength and rigidity in proportion to its size and weight. Secondly, it is shock-absorbent, uniform throughout, dimensionally accurate, and possesses excellent machining and superior welding properties. It is produced under rigid standards, and is available in a generous range of diameters, wall thicknesses, various shapes and steel analyses. And it can be fitted to your specifications, regardless of what they are. Our engineers will help you adapt Shelby Seamless to your requirements.

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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS SHELBY SEAMLESS MECHANICAL TUBING

UNITED STATES STEEL

A low, powerful-looking silhouette moves swiftly onto the field, spits a few rounds of .50-caliber tracers seeking its target – then lets loose a terrible salvo from six big rifles. Before you can get a good look at it, the thing whirls and vanishes.

The name is ONTOS – a Greek word meaning "the thing." Based on a new concept in armored warfare, ONTOS was developed by Allis-Chalmers for Army Ordnance and is now being produced for the Marine Corps.

Mounting six 106-mm recoilless rifles, the deadly vehicle also carries four .50-caliber spotting rifles and a .30-caliber machine gun. The rifles can be step-fired in salvos of two, fired individually or in a single knockout salvo of six. A "hit-and-run" weapon, ONTOS depends for its punch on quick and accurate firing of its multiple guns, plus its amazing maneuverability on any terrain. ALLIS-CHALMERS, GENERAL OFFICES, MILWAUKEE 1, WISCONSIN.

ALLIS-CHALMERS

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Book REVIEWS

Reviews in this issue by:

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

COL. LEO A. CODD, *editor of* ORDNANCE, *Washington, D. C.*

COL. JOHN J. DRISCOLL, *author, air armament engineer, Weapons Systems Evaluation Group, Office, Secretary of Defense, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

MELVIN M. JOHNSON, JR., *automatic arms expert, author, New Haven, Conn.*

COL. CHARLES MCKNIGHT, *U.S.A. (Ret.), ordnance engineer, metallurgist, historian, and former company executive, Fork, Md.*

COL. CHARLES G. METTLER, *U.S.A. (Ret.), artillerist, former Army Ordnance arsenal and depot commander and U. S. military attaché abroad, Miami Beach, Fla.*

CAPT. J. M. P. WRIGHT, *U.S.N. (Ret.), naval ordnance engineer, logistician, editor, Washington, D. C.*

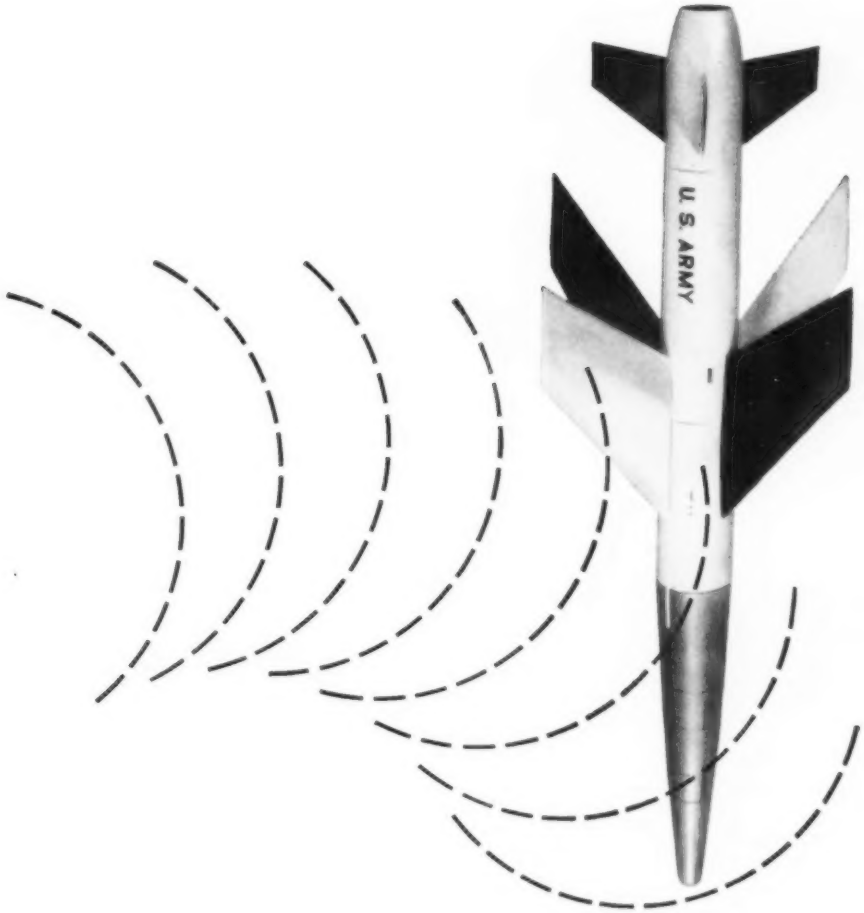
The Sea War in Korea. By Comdr. Malcolm W. Cagle and Comdr. Frank A. Manson. Annapolis: United States Naval Institute. 560 pp. $6.

NAVAL operations in the Korean war, probably the last sizable conflict with conventional weapons, reaffirmed the importance of control of the sea. Most of the functions a navy must perform to keep and to utilize its control were undertaken in this strange and frustrating 3-year clash and are recounted in this war history.

"Sea War in Korea" is more than a factual account as the authors accompany their story with well-considered analyses that emphasize the lessons to be learned. The hundreds of small air and sea actions are covered by quoting from a few, well-related accounts of eyewitnesses. In major actions, the commanders, such as Vice Admiral Struble, Lieutenant General Van Fleet, and Vice Admiral Joy, are quoted in a manner that illuminates their problems and explains their decisions. And many previously untold incidents appear here for the first time.

The authors leave no stone unturned to show how each event was influenced or made possible by control of the sea; yet they recognize but briefly that operations were less complex due to lack of enemy opposition in the air or underwater—a strange situation for a navy manned by many World War II sailors. Even the harbors of Sasebo and Pusan, crammed with ships packed with flammables and high explosives, were never molested.

One great omission—not unusual for all historians—is the small reference made to the vast logistic support effort.—J. M. P. WRIGHT. *(Continued on p. 504)*



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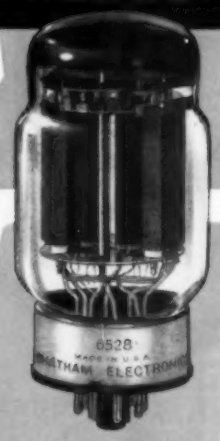

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Max. Steady State Plate Current per section...300 ma
Max. Plate Voltage.....400 volts
Max. Heater Cathode Voltage.....300 volts
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Transconductance per section*.....37,000 μmhos
*Average characteristics at Eb = 100v, Ec = —4v, Ib = 185 ma.

TYPICAL VALUES FOR REGULATOR SERVICE

Current per Triode Section	Range of Tube Voltage Drop	Minimum Tube Drop	Grid Voltage Swing
200 ma	65 v.	70 v.	10 v.
150	120	60	20
100	225	45	35

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Book Reviews (Contd.)

Baruch—My Own Story. By Bernard M. Baruch. New York: Henry Holt & Company. 337 pp. $5.

MEMBERS of the Ordnance fraternity need only slight prodding—if at all—to recall the superlative work of their fellow member for armament preparedness in two world wars. He was chairman of the War Industries Board in the First World War and adviser to President Roosevelt in the Second.

This book, written in free and candid narrative, portrays principally the private life of the author. A second volume to be published later will be devoted to the public record. Here are described his family background, his high-principled father and mother, his first steps in Wall Street, his speculations on the future of industrial empires in transportation, in raw materials, and in other commercial undertakings.

That he became a millionaire when in his early thirties and went on to great position and wealth was due to his ability, his industry, and his fair dealing.

Naturally, this journal is concerned principally with the author's references (which will probably be in much greater detail in the next volume) to his well-known doctrines on how to mobilize the economy of the Nation for major war. Had his tenets in this field been followed in World War II, our national debt today would be but a fraction of its present staggering total. The following quotation is in point:

"There are some problems on whose solution we must wait for the workings of time. But with many other problems inaction is the worst possible course. For example, my experience as Chairman of the War Industries Board in World War I taught that if inflation and profiteering were to be prevented in a second war, a ceiling would have to be imposed on all prices, wages, rents, and profits at the very start of the emergency.

"But when World War II started, both President Franklin Roosevelt and Congress decided to 'wait and see.' The necessary over-all ceilings were not imposed for two years, and then only after the inflationary race was on. The same process of wait and see was repeated with the Korean war.

"If effective measures to prevent inflation had been taken at the outset of both these conflicts, the burden of our national debt would be hardly half of what it is now."

Hindsight, you say? Consult the files of this magazine during the 1920's and 1930's. Its pages are filled with Mr. Baruch's pleadings in this same vein. Verily he was a prophet crying in the wilderness.—Leo A. Codd.

Limited War—The Challenge to American Strategy. By Robert Endicott Osgood. Chicago: University of Chicago Press. 315 pp. $5.

ALL advance planning strictly for defense is subject to one inevitable fault—namely, the endless labyrinthic attempts to cover every possible phase of enemy thinking. Each solution of a problem uncovers a multitude of other possible problems until the planning is involved in interminable prolixity.

This book itself has not escaped the fault. It is an excellent analysis, but it is too compendious and profound to reach further than a restricted class of readers. If the arguments and conclusions of the book were digested in less stately language to one-third the present length, the book might well stir the Nation.

The author believes that we have done a superior job in planning for total war but that under present over-all policies it is impossible to plan for limited war and that we thus are doomed to rely on improvisation. He feels that it would be difficult to conceive of Russia precipitating total war. Believing in the ultimate triumph of their cause, and having a stolid patience, the Russian leaders prefer stealthy indirect methods, holding their military power only as an implicit threat and pursuing their aims with flexibility and resourcefulness among lesser

states, gaining these states to their orbit by "liberation" while they would denounce any positive action by us as "aggression."

Lenin stated: "We are struggling not against wars in general, but against reactionary wars, and *for* revolutionary wars."

As a case in point, the stirring up of a Communist revolution in an Arab state where scarcely more than one per cent of the people are Communists, is, in the Communist thinking, a just war of "liberation." Any positive action on our part to free the ninety-nine per cent from the dominance of Communism would be deemed an unjust reactionary war of conquest.

Planning for limited war, through which our policy of containment could be made effective and real, is thus not possible from the military angle because our diplomacy forbids it. The author believes that the idea of war as a continuation of political intercourse is the very essence of Communist theory and practice but that the Communists do not recognize our definitions of war and peace.

The standard Russian policy is a devious bargaining and maneuvering for position, with every temporary compromise made only with the object of future gain, and no moral squeamishness in casting aside the compromise when the time comes. It is no more possible for our diplomats to bargain with that policy than it would be for police officials to bargain with organized criminal gangs.

It is deduced from the book that any military planning for "containment" is impossible until there is an effective, recognized, diplomatic policy to stop the advance of the Communist wars of "liberation." Until we have such a policy, the author believes that we are doomed to an indefinitely prolonged period of expensive prolix planning and mammoth defense budgets, exactly as the Communists plan for us. The book is well worth study.—GEORGE S. BRADY.

The War Potential of Nations. By Klaus Knorr. Princeton: Princeton University Press. 310 pp. $5.

DOCTOR Knorr clarifies the theory of war potential in a manner refreshingly free from economist's jargon, yet without talking down to the reader. Only supporting reference is made to mobilized military strength, and bare mention is made of diplomacy, economic warfare, propaganda, and suasion. The components of war potential are reduced to a basic three: economic capacity, administrative competence, and motivation for war—materials, men, morale.

Doctor Knorr deals at considerable length with the rôle of war potential in

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the nuclear age. Contrary to the opinion of many, expert and layman alike, he holds that war potential is not static but changing and growing with modern developments. He predicts that war potential mobilization will be a valuable aid in all the probable types of nuclear warfare from the obliteration attack down to the "brush-fire" war.—CHARLES MCKNIGHT.

The Magsaysay Story. By Carlos P. Romulo and Marvin M. Gray. New York: John Day Company. 316 pp. $5.

HERE is an enthusiastically appreciative biography of Ramon Magsaysay, late President of the Philippine Republic, who was killed in an airplane crash in the Philippines after this book was published. Apparently the two authors have exhausted all sources of information to produce such an intimate and authentic picture of this man, who was born in the little barrio of Iba, between Camp Stotsenburg and Subig Bay Naval Station, to a poor teacher in the local trade school, and who worked fearlessly and honestly upward to the highest office of his nation.

The life story is most interesting in itself. The political struggle by which this splendid guerrilla leader secured his elections under the pressure of his many ardent admirers is also remarkable for the picture it presents of Filipino nominations, elections, and appointments to government positions.

For Magsaysay, a poor country boy fighting for an education and succeeding in getting his degree from the José Rizal college in Manila, the revelation of the political duplicity and wickedness of the powerful Manila clique in control of the government, content with its loot and its scheming, while the Huks were gradually taking over the country for the Russians, awakened his latent strength to save the state. From his successful experience with the guerrillas under some competent American officers, he offered his plan for the defeat of the Huks and became the head of the national defense.

His plan succeeded. The world acclaimed his remarkable successes. He turned upon the political hangers-on and with the Filipino people behind him, he drove them out of the temples. He became the dynamic leader. The votes of all the people began to be counted again. The miserable barrios began to get schoolhouses and artesian wells. A multitude of projects were inaugurated to improve Filipino life. The propaganda of the Communists began to be disregarded, and the belligerent Huks began to come into the new life, to get land, and to be a part of the economy of the nation.

Now that Magsaysay has gone, and at the very peak of his brilliant work, he will find a niche in the Hall of Fame in Manila.

I recommend the book to all people interested in good government and particularly to those who are interested in the successful future of the Philippine Republic.—CHARLES G. METTLER.

Global Strategy. By Air Vice Marshal E. J. Kingston-McCloughry. New York: Frederick A. Praeger. 270 pp. $4.50.

THE Air Vice Marshal necessarily writes as an Englishman, and from the British viewpoint. This necessitates a rather radical reëvaluation of many of his arguments, in view of Great Britain's substantial cuts in her defense commitments. And especially is the clear view of the Middle East changed by the attack on Egypt with its vast repercussions. The author ably demonstrates that the withdrawal of either France or West Germany would mean great changes in global strategy. All told, it poses a grave question: Is not the United States becoming too preoccupied with and dependent upon European aid?

Britain's recognition of and trade with Red China might possibly explain the author's tendency to differentiate between "Russia" and Communism, for he is sincerely opposed to the latter. From the first, he speaks frankly of "striking at the home front," *i.e.*, the civilian population, by aërial bombing. One wonders if airmen realize how many thoughtful, militarily informed people oppose easy acceptance of this doctrine (so often termed "mass murder").

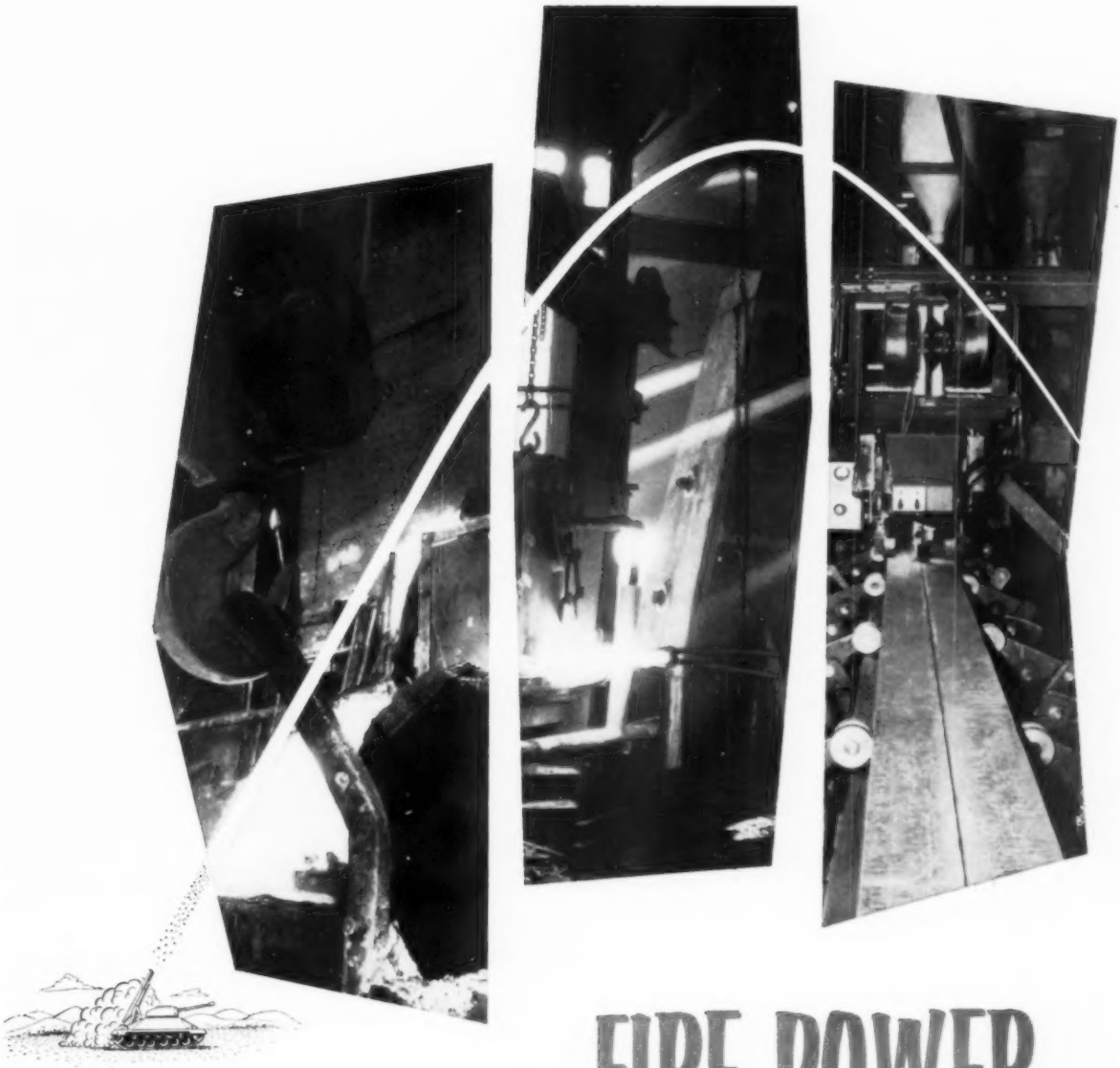
The book opens with a very good summary of "the evolution of war," and the development of the air arm in modern strategy. While it does not reach definitive answers on the problems of the global strategy of today and tomorrow, it does lead the inquiring mind into disciplined channels of thought which are sorely needed in such a vital affair.—F. W. FOSTER GLEASON.

Gas, Air, and Spring Guns of the World. By W. H. B. Smith. Harrisburg: Military Service Publishing Company. 279 pp. $7.50.

WALTER SMITH has made still another interesting and useful contribution to all libraries of weapon lore. This volume leaves out little if anything in this field of target, training, and "indoor" sporting arms.

The author especially emphasizes the amazing indoor short-range accuracy coupled with terminal ballistic safety of many "air" rifles and pistols. He notes that Daisy sells some 1,500,000 air guns a year; that Crosman Arms has some $2,000,000 net sales per year.

(*Continued on p. 509*)



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The author conducted a lot of tests on various "air" weapons. He reports on .22 "air" pellet muzzle velocities of 300 to 780 feet a second, chamber pressures under 1,000 pounds per square inch, small-bore rifle accuracy at 25 feet.

Shooting as a sport seems on the upsurge since Korea, and "air" guns are for kids of all ages. Walter Smith has made another of his fine characteristic contributions to the cause of small arms and training.—MELVIN M. JOHNSON, JR.

Egypt's Rôle in World Affairs. By Emil Lengyel. Washington: Public Affairs Press. 147 pp. $2.50.

EMIL LENGYEL, currently a history professor at New York University, presents a treatise dealing with the relationship of Egypt with the nations most affecting her fate—the Arab neighbors, Israel, Soviet Russia, Britain, and France. The author's analysis of Egypt's new dynamism begins with an excellent summary background of Egyptian history sorely needed by the average American. The text is built around the "week that shook the world"—the Franco-British-supported Israeli attack against Egypt, beginning October 29, 1956.

Incorporated in this book is a good review of American and Soviet policies leading to and emanating from the recent Egyptian conflict. The author makes an obviously determined effort to present an unbiased historical analysis and gives the excellent advice, with specific recommendations, that the United States must take decisive action to preclude the Middle East's falling under the totalitarian yoke.

Four very relevant documents are appended to the book: The August 17, 1956, speech of Christian Pineau; the November 1st statement by Egypt's U. N. delegate; the November 13th address by the Egyptian ambassador to the U.S.S.R.; and the November 23rd statement to the U. N. General Assembly by Israel's ambassador to the U. S.

BOOKS RECEIVED

Basic Mathematics for Radio and Electronics. By F. M. Colebrook and J. W. Head. New York: Philosophical Library. 359 pp. $6.

Basic Physics. By Alexander Efron. New York: John F. Rider Publisher, Inc. 724 pp. $7.60.

Career Satisfactions of Professional Engineers in Industry. A Research Survey for the Professional Engineers Conference Board for Industry in Coöperation with the National Society of Professional Engineers. Washington, D. C. 84 pp. $3 (nonmembers), $1.50 (NSPE members).

Elements of Heat Transfer. By Max Jakob and George A. Hawkins. New York: John Wiley & Sons, Inc. 317 pp. $6.75.

Engineering Manpower: How To Improve Its Productivity. A Special Report for Management by Students at the Graduate School of Business Administration, Harvard University. Cambridge, Mass.: Engineering Management Reports. 162 pp. $18.50.

Fasteners Handbook. By Julius Soled. New York: Reinhold Publishing Corporation. 430 pp. $12.50.

History of Entomology in World War II. By Emory C. Cushing. Washington: Smithsonian Institution. 117 pp. NP.

Industrial Plant Protection. By John Richelieu Davis. Springfield, Ill.: Charles C. Thomas, Publisher. 566 pp. $12.

Making of a Moon, The. By Arthur C. Clarke. New York: Harper & Brothers. 205 pp. $3.50.

Metrology of Gage Blocks. Proceedings of a Symposium on Gage Blocks held at NBS August 11 and 12, 1955. National Bureau of Standards Circular 581, issued April 1, 1957. Washington: U. S. Government Printing Office. 119 pp. $1.50.

Nuclear Power Reactors. By James K. Pickard. New York: D. Van Nostrand Company. 388 pp. $8.50.

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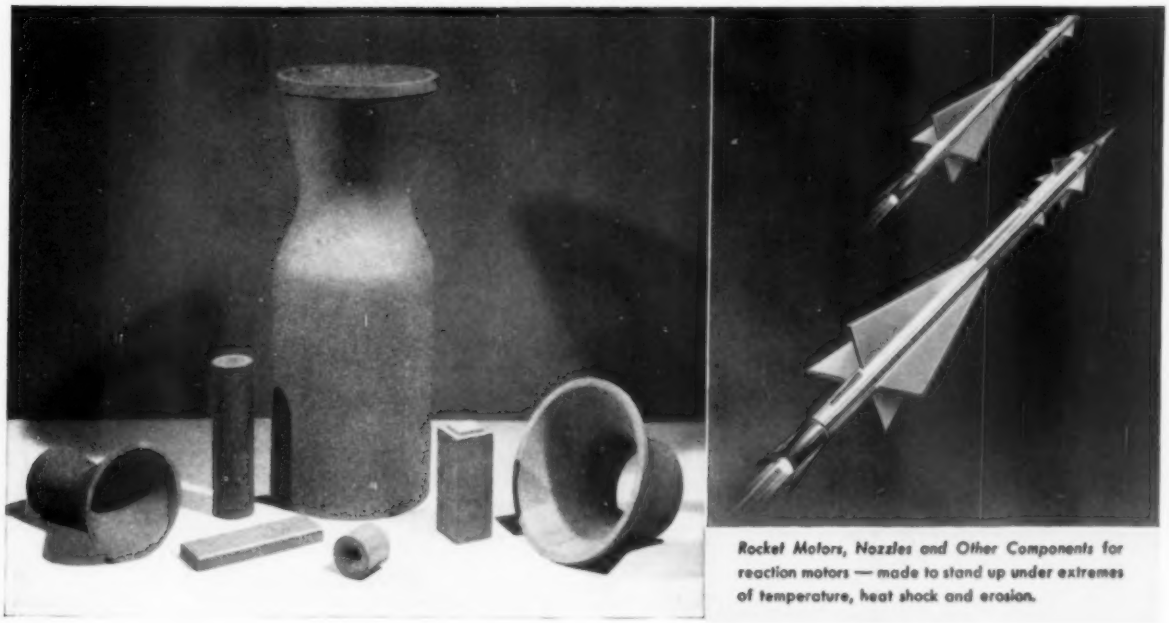


Rocket Motors, Nozzles and Other Components for reaction motors — made to stand up under extremes of temperature, heat shock and erosion.

NEW CERAMIC COATINGS & COMPONENTS FOR MISSILES AND ROCKETS

To meet the exacting requirements and to aid the performance of reaction motors, Norton Company has developed several new silicon carbide products. Among these are: ROKIDE* "C" silicon carbide coating on graphite; CRYSTOLON* "R" recrystallized silicon carbide and CRYSTOLON "N" nitride-bonded silicon carbide bodies.

ROKIDE "C" Silicon Carbide Coating

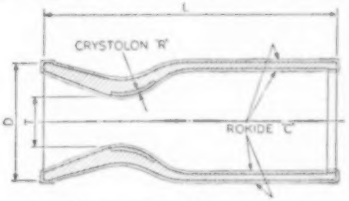
This hard, crystalline coating protects light weight, thermal shock resistant graphite — gives it excellent resistance to erosion and oxidation — and makes it highly suited for use in rocket motors. ROKIDE "C" coating on graphite has found ready use for combustion chambers and exit cones of uncooled rocket motors as well as for ramjet exhaust nozzles.

CRYSTOLON "R" and "N" Silicon Carbide Bodies

Components of CRYSTOLON "R" recrystallized silicon carbide and CRYSTOLON "N" nitride-bonded silicon carbide have excellent erosion, thermal shock and oxidation resistance, good strength, low density and thermal conductivity. They can be made in a wide variety of shapes and sizes.

TWO-WAY PROTECTION IN A ROCKET MOTOR

ROKIDE "C" coating protects this entire rocket motor, while CRYSTOLON "R" silicon carbide gives added protection and strength to the narrower throat



area where conditions are most severe.

DIMENSIONAL LIMITS

	Diameters	Lengths	Throats
ROKIDE "C"	½" to 24"	½" to 30"	3/16" to 22"
CRYSTOLON "R"			
CRYSTOLON "N"	¾" to 18"	¾" to 20"	3/8" to 16"

For further information on these NORTON developments for reaction motors, write to NORTON COMPANY, New Products Department, 750 New Bond Street, Worcester 6, Massachusetts.

NORTON

NEW PRODUCTS

Making better products . . . to make your products better

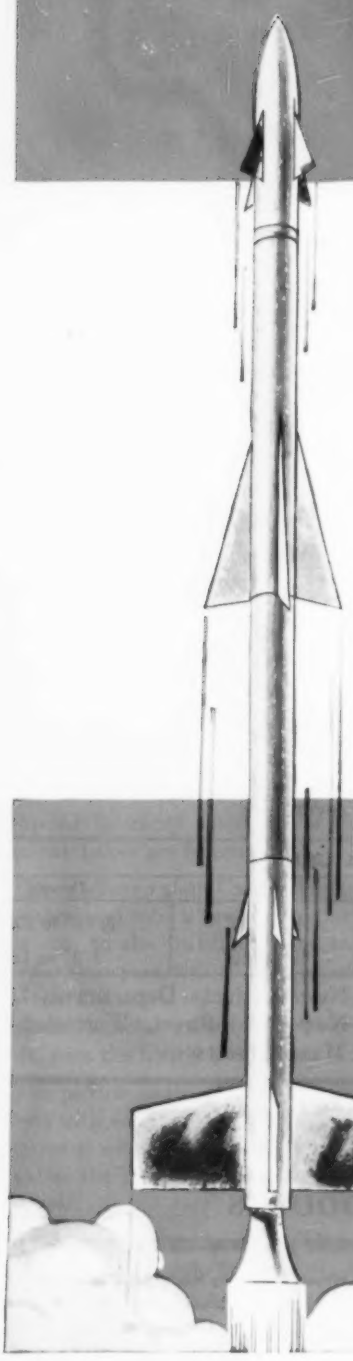
NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories
BEHR-MANNING DIVISION Coated Abrasives • Sharpening Stones • Behr-cat Tapes

*Trade-Marks Reg. U.S. Pat. Off. and Foreign Countries

SPEED YOUR MISSILE

Precision Weldments in Stainless

FROM THE LEADING PRODUCER



Welding of all types on special steels and alloys can be contracted for confidently at the Jet Division.

Our experience in forming, welding, stress-relieving, and heat-treating titanium, high-alloy and stainless steels for jet engine components is available to you now for your missile programs. Deliveries will be prompt, quality will be to your required standards. Our engineering staff can also help you design and engineer weldments of all types.

Machining of weldments can also be done right in our own plant by people accustomed to closest tolerances, unusual alloys and designs, and aircraft-quality standards.

Let the Jet Division supplement your own overloaded missile production facilities. Capital investment will be eliminated, the search for qualified engineers and production people will be avoided. Delivery will be made to suit your production schedule. Write today for a Jet Division Sales Engineer to call.

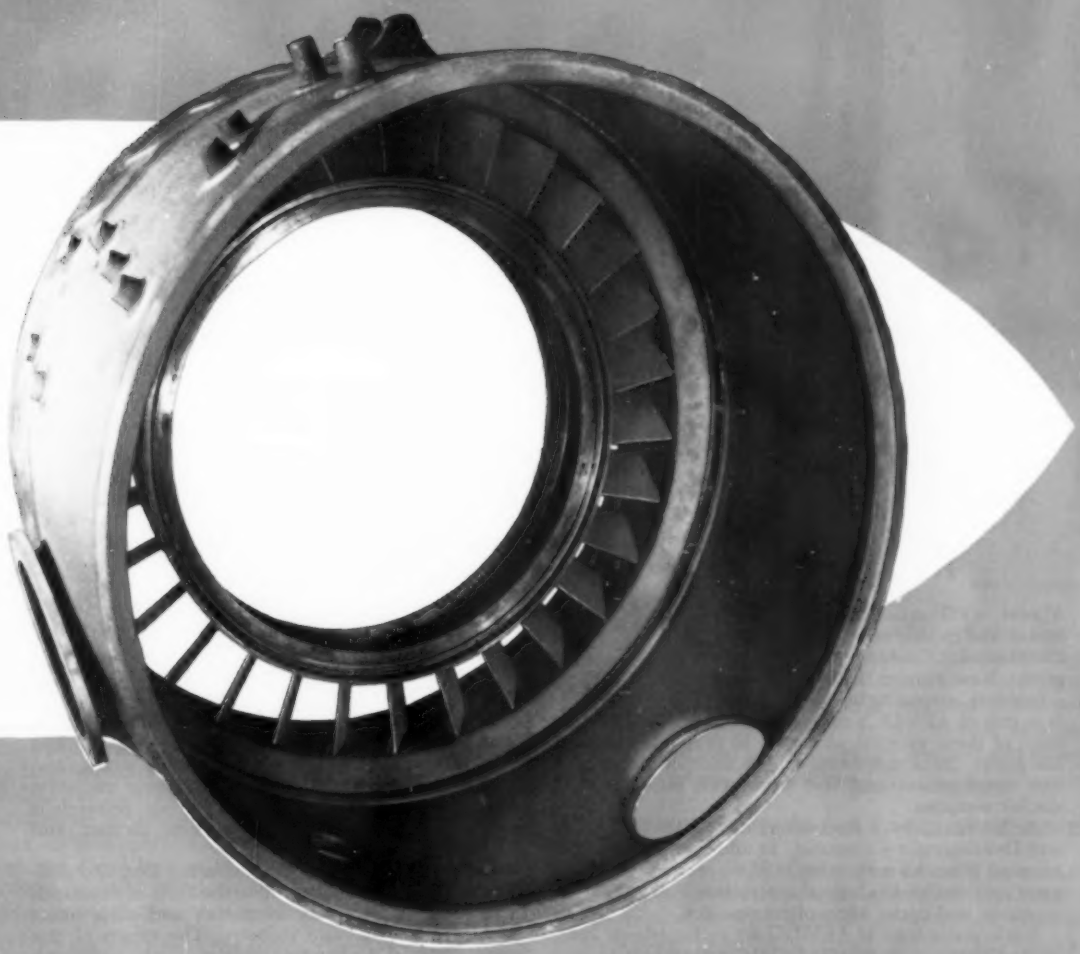
SEND FOR BOOKLET O-357

which describes the facilities and products of the Jet Division in detail, shows how you can use these facilities to best advantage.

PROGRAM WITH

and High-Alloy Steels and Titanium

OF JET-ENGINE PARTS



JET DIVISION

Thompson Products, Inc.

CLEVELAND 17, OHIO

U. S. Air Force Photo

"Moby Dick" high altitude research balloon being launched from a special protective trailer at AFMDC. This balloon carries instruments up many miles. Small sized balloon alongside provides launch crew with information on surface wind velocity and direction.

SCIENTISTS ARE OPENING DOOR TO OUTER SPACE AT AIR FORCE MISSILE DEVELOPMENT CENTER

Almost 4000 square miles of desert comprise the rocket and missile test range at the Air Force Missile Development Center at Holloman AFB, near Alamogordo, New Mexico. In another sense, the test range is limitless, extending upwards to the reaches of space. It is one of AFMDC's missions to extend our knowledge of these extreme altitudes, to prepare man for life above the atmosphere—this in addition to extensive development and test work with missiles and similar weapons.

AFMDC is one of the centers of the Air Research and Development Command. In addition to its basic mission, it works with other ARDC centers, government agencies and industrial contractors in electronics, weapons, and upper atmosphere research.

Undergoing tests at AFMDC are surface-to-air and air-to-air supersonic missiles for intercepting hostile aircraft; air-to-surface missiles; surface-to-surface guided missiles, and many similar weapons.

Instruments and biological specimens are carried skyward in experimental rockets and balloons at AFMDC for studies of radio wave propagation at high frequencies; investigation of electrical characteristics of the ionosphere and composition and acoustical properties of upper atmospheres; studies of the intensity of radiation from the sun, from nocturnal space, and from the earth; studies of high altitude winds, and studies of the biological effects of cosmic radiation and reduced gravity. This high altitude research is useful in the development of missiles, aircraft, and associated equipment.

Gleaning this useful information is a long and difficult business which draws upon the skills of thousands of civilian and military engineers and their many counterparts in private industry. The efforts of this small army of technicians will not only determine America's ability to meet potential aggressors, but bring ever closer the coming Age of Space.

This is one of a series of ads on the technical activities of the Department of Defense.

FORD INSTRUMENT CO.

DIVISION OF SPERRY RAND CORPORATION

31-10 Thomson Avenue, Long Island City 1, New York

Beverly Hills, Cal. • Dayton, Ohio

Technicians in Ford Instrument's gyro laboratory perform tests on subassembly from missile guidance system.

ENGINEERS of unusual abilities can find a future at **FORD INSTRUMENT CO.** Write for information.

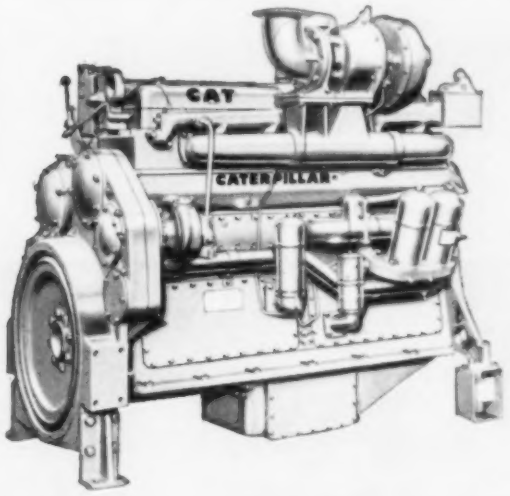
CATERPILLAR ANNOUNCES

Another heavy-duty engine in the world's most advanced line of Diesels

D397	D375	D342	D339	D337	D326	D318 (SERIES G)	D315 (SERIES G)	D318	D315	D311
650 HP†	430 HP†	225 HP†	140 HP†	310 HP†	200 HP†	175 HP†	115 HP†	137 HP†	91 HP†	65 HP†

New D353

390 HP†



Length 75⅜"
Width 47½"
Height 69¼"

†Maximum output capacity

The engine that delivered outstanding performance in the famous D9 Tractor is now available as the D353 Industrial Engine, Electric Set and Marine Engine. Like all modern CAT* Diesels, the D353 incorporates in its design the advanced features developed by Caterpillar in a quarter century of diesel leadership. Its four-cycle design delivers the long, effective power stroke that puts power to more efficient use than other types of engines. Its fuel system requires no adjustment. There are no cylinder ports to clean. And it operates on a wide range of fuels including premium diesel fuels as well as low-cost No. 2 furnace oil *without fouling.* All these and other features add up to performance that no unit in its power class can match.

With the addition of the D353 to the Caterpillar Engine line, you now have an even wider choice than ever for your requirements. Engines are available up to 650 HP (maximum output capacity) and electric sets up to 350 KW (continuous duty). Either as original or replacement power, there's one among hundreds of different arrangements that exactly meets your needs. Leading manufacturers of machinery can supply these models in the equipment they build.

For complete information about the new D353 and other Cat Diesels, see your Caterpillar Dealer. Let him show you how diesel leadership based on a quarter century of experience can engineer the modern heavy-duty diesels of tomorrow.

The new Cat D353 Engine is a six-cylinder, four-cycle, valve-in-head turbocharged diesel. It is available as an electric set rated at 200 KW (continuous duty) and as a marine engine. A full line of matched attachments is also available — items such as air, electric and gasoline starting systems; clutches; bases; controls and governors; cooling systems and mufflers.

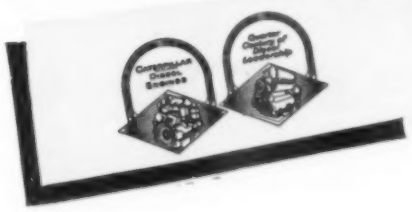
CERTIFIED POWER FOR CAT DIESEL ENGINES

Through the years, Caterpillar Engines have earned a reputation for *honestly rated power.* Now Caterpillar backs this reputation with a *notarized certificate* covering the horsepower capabilities of each engine. You have a right to demand *certified power* when you invest in an engine. You get it when you buy from your Caterpillar Dealer!

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.



This is

NATIONAL NORTHERN

...newest AP&CC division

Dedicated to research, development and production in

rocket power technology

Test a rocket motor's performance at 100,000 feet altitude... determine how extremes of temperature affect explosive and propellant charges... develop igniters of maximum sturdiness and reliability. These are typical activities at National Northern Division, West Hanover, Mass., latest addition to the AMERICAN POTASH family. Here, a qualified staff of scientists and technicians conducts research, development, field testing and production of propellants for rockets and missiles, explosives, pyrotechnics, detonators, igniters, squibs, gas generators, fuzes and other items.

Extreme environmental conditions are simulated in the laboratory or encountered in actual field tests on the firing range at West Hanover or the 1900-acre test range at Halifax, Mass. Here, too, AP&CC will extend its facilities for the investigation and development of TRONA* boron, lithium and perchlorate chemicals in high energy fuels.

For more than ten years National Northern has demonstrated its ability to work in close coordination with others. As an integral part of AMERICAN POTASH & CHEMICAL CORPORATION it is ready to go to work for you!

We invite inquiries leading to research and production contracts.

NATIONAL NORTHERN'S CURRENT FIELDS OF ACTIVITY:

ROCKET-MOTOR-IGNITER DEVELOPMENT • GAS GENERATORS • SURVEILLANCE TESTING OF EXPLOSIVES AND AMMUNITION • EFFECT OF ALTITUDE ON PERFORMANCE OF EXPLOSIVES, PROPELLANTS, TRACERS AND INCENDIARY ELEMENTS • DESIGN OF ELECTRIC DETONATORS AND SQUIBS • AIRCRAFT VULNERABILITY TESTS AND EVALUATION • EXPLOSIVE METAL FORMING

TRONA

American Potash & Chemical Corporation

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99 PARK AVENUE, NEW YORK 16, NEW YORK
NATIONAL NORTHERN DIVISION
P. O. BOX 175, WEST HANOVER, MASSACHUSETTS

*TRADEMARK AP&CC

NEW KIND OF NAVY CRAFT!

Lightweight Solar gas turbine proves sensational performance in high-speed hull

Pioneered by the Navy, a new type of work boat is born!

THIS ADVANCE-DESIGN LANDING CRAFT introduces a new concept in Navy operations—and also opens new fields of usefulness for commercial work boats. Powered by a 500 hp Jupiter® gas turbine engine, it demonstrates startling new advantages over boats with conventional marine propulsion units.

During high-speed test runs the 40-foot LCPL greatly increased the speed achieved with the latest marine diesel—yet the Jupiter weighs only two-thirds as much as the diesel engine tested! Compact and lightweight, with a high power-to-weight ratio, the Jupiter is easy to maintain and operates for long periods without overhaul. It starts instantly after long periods of inoperation and can burn a wide variety of fuels—including gasoline, kerosene, diesel oil and others.

Increased speeds reduce the time required for naval and commercial work boat operation—and the Jupiter's low weight and high performance standards can get the job done with lower overall costs. This versatile engine is also used aboard advanced minesweepers and destroyers as a reliable emergency power source—and for other shipboard uses. For a new gas turbine brochure write to Dept. D-93, Solar Aircraft Co., San Diego 12, Calif.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

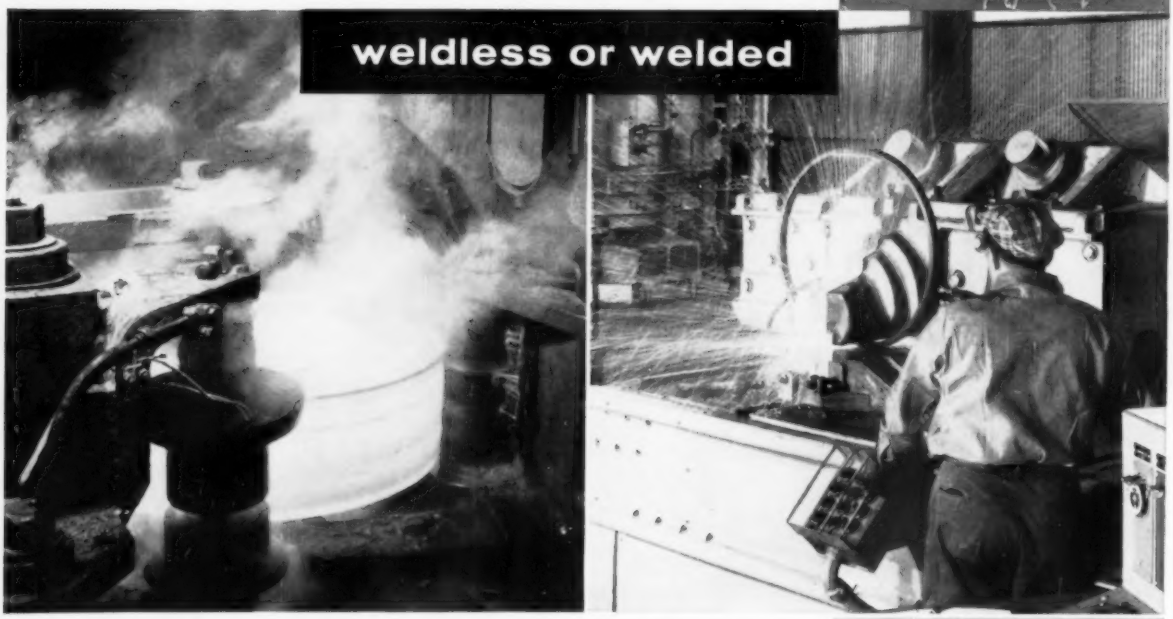
DESIGNERS, DEVELOPERS AND MANUFACTURERS • GAS TURBINES • AIRCRAFT AND MISSILE COMPONENTS • BELLOWS • CONTROLS • COATINGS METAL ALLOY PRODUCTS

for ordnance equipment

Edgewater RINGS

meet your most critical specifications—save time and material

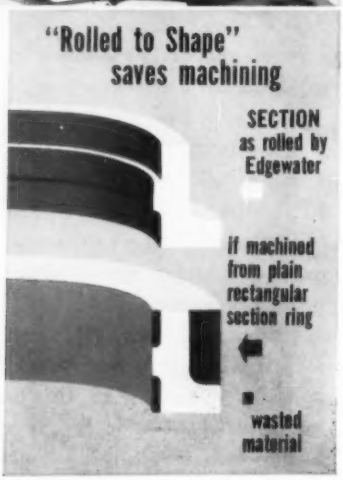
Accurately formed, in a wide variety of sizes and cross-section shapes, Edgewater Rings meet the most exacting service requirements. Edgewater rings save costly material and machining time because a minimum of finishing is required. Materials include carbon and alloy steels, stainless, tool steels and titanium.



Edgewater Weldless Rings are rolled from solid steel blocks, and are close to finish size and shape as rolled. Diameters 5 to 145 inches.

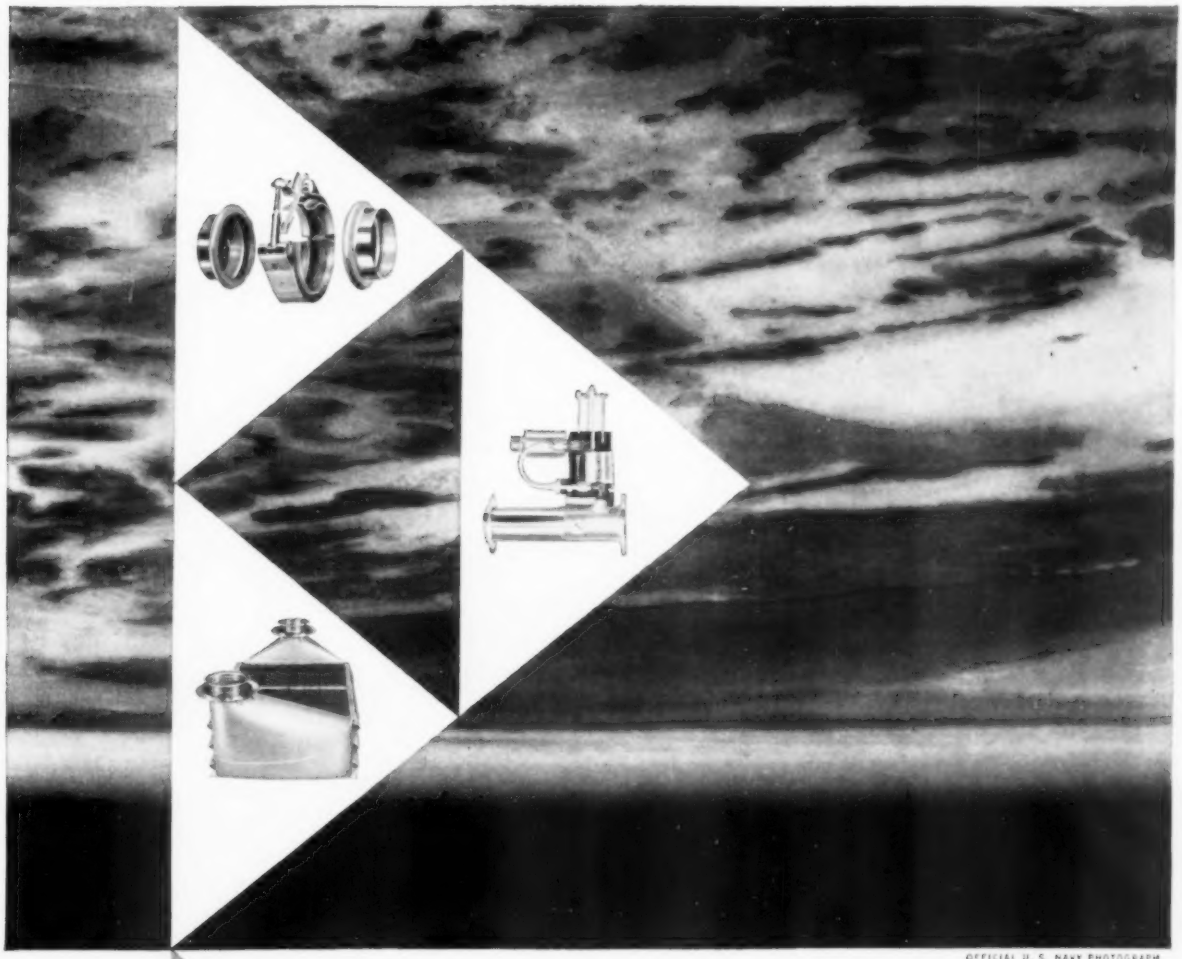
Edgewater Welded Rings are formed from bars rolled or extruded to shape, and welded by modern electronically-controlled equipment. Diameters up to 48 inches.

Write for bulletins describing how Edgewater Rings, both weldless and welded, are made. They include drawings of typical ring sections.



Edgewater Steel Company

P. O. Box 478 • PITTSBURGH 30, PENNA.



OFFICIAL U. S. NAVY PHOTOGRAPH

three Janitrol® answers to exciting new problems!

Janitrol couplings for bleed air ducts provide positive metal-to-metal seal, are easily installed in tight spots, stay pressure-tight after repeated disconnects —and in addition give lowest weight per coupling yet achieved.

Janitrol pneumatic valves and regulators bring new versatility, light weight and dependability to air distribution systems for tank pressurization, canopy seal, and other vital air-powered devices.

Janitrol Platular® heat exchangers combine the efficiency of tubes, the strength of plates, and the simplicity of modular construction. They offer new compactness, high performance, and freedom of design in restricted spaces.

If your company is making major investments in jets and missiles for the future, Janitrol's resources can serve you well. They have carried a broad range of aircraft hardware out of the design stage into proven realities. Your Janitrol representative invites your inquiry . . . Janitrol Aircraft-Automotive Division, Surface Combustion Corporation, Columbus 16, Ohio.

FRONT-LINE STORY

Seen and heard at Command Post by means of world's smallest TV and Radio Communication facilities

Transistorized radio receiver transmitter completely concealed in helmet has up to 5-mile range.

"Telemite," smallest TV camera, features newly developed RCA ½-inch Vidicon tube, size 1⅞" x 2⅜" x 4¾", weighs about one pound.

The soldier you see carries the new RCA one-pound, postcard-size ultra-miniaturized TV camera connected to a miniature TV transmitter on his back. Concealed in his helmet is a complete radio receiving-transmitting set weighing only a few ounces. He is one of several similarly equipped men covering the battle area from a number of positions in the air and on the ground.

At the command post the troop commander *SEES* enemy movements on television screens and *HEARS* first-hand reports. Their resulting immediate control of the situation is based upon accurate, instantaneous first-hand knowledge.

In achieving this miracle of miniaturization, through the use of transistors, printed circuits and the latest electronic technology, RCA has again made a major contribution to the industry and all our armed services.

DEFENSE ELECTRONIC PRODUCTS

RADIO CORPORATION of AMERICA

CAMDEN, N. J.

Tmk(s) ®

Glasco pre-mix dispensing machines are manufactured by Glascock Bros. Manufacturing Company, Muncie, Indiana.

Add COPPER

...and it serves your drink cold!

Your soft drink from a dispensing machine is served *ice cold* because of Copper. For Copper is the *best* heat-transfer material commercially available. *Copper dissipates heat faster.* That's why the coolant-carrying tubes . . . and fins . . . inside the dispenser are Copper.

And that's why Copper is the metal preferred for air-conditioners to keep you cool at home or at work.

Even the big, new liquid-cooled generators are kept cool with Copper.

Copper has other invaluable properties, too. Because it is the best practical conductor of electricity, wiring and motor-windings are made of Copper. Copper resists corrosion. (It simply won't rust!)

In manufacturing processes, Copper has always been a great metal to *work* with. It proves easy to machine, form, draw, stamp, polish, plate. It welds readily . . . is excellent for soldering and brazing. Besides, you recover a higher portion of your materials cost from the higher-cash-value of your manufacturing scrap!

And today, you can plan with Copper . . . confident that the Copper Industry will keep Copper in ample supply to meet your future needs.

COPPER • BRASS • BRONZE

in over 40 Standard Alloys!

For information on cooling or any other application of Copper, write to the Copper & Brass Research Association, 420 Lexington Ave., New York 17, N. Y.

© 1946 CHAS ADDAMS

FOR *almost* ANY MISSILE, ANYWHERE ...CREATIVE ENGINEERING BY CLEVELAND PNEUMATIC

Our Special Products Division designs and builds launching stands, test towers, ground-movement vehicles, and storage devices for *almost* any size missile, anywhere.

What do we know about ground-support devices for missiles?

Since 1924, Cleveland Pneumatic has been developing and building cushioning devices. Impact absorbers . . . structural units . . . for large and cumbersome loads.

Our ideas on ground-support vehicles and structures for missiles are firmly based on 33 years of experience.

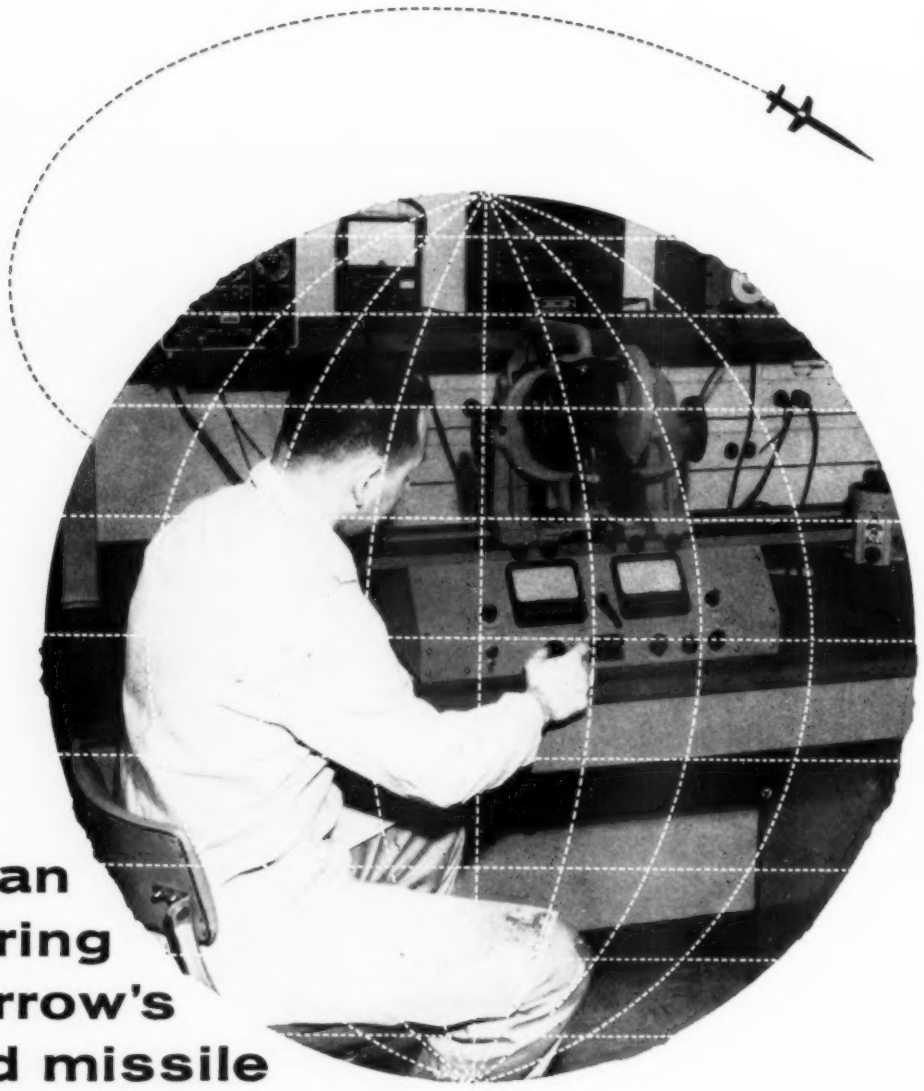
May we call on you soon to discuss your missile and its ground-support requirements?

Your missile project ...and creative engineering

This new booklet outlines in detail the abilities and facilities of the Special Products Division. For your copy, write on your company letterhead to Cleveland Pneumatic Tool Co., Special Products Division, Cleveland 5, Ohio.

CLEVELAND PNEUMATIC

TOOL COMPANY • SPECIAL PRODUCTS DIVISION



This man is steering tomorrow's guided missile

His uniform is a laboratory coat, his cockpit a dust-free room with carefully controlled temperature and humidity. He's a skilled General Mills gyro technician—as much a part of the defense of his country as the jet pilot. Results from his work, and from work in other R & D labs, assure us that tomorrow's guided missiles will be even more accurate than today's. ¶ At the Mechanical Division of General Mills, the gyro lab is part of a talented, well equipped guidance and navigation systems development group. The group also includes top men and facilities in infrared, microwaves, electronic and mechanical design, and overall systems engineering. We team these men and facilities with a complete precision production plant to handle systems, sub-systems and major assembly problems for the world's most exacting customers. Possibly you too can benefit from our capabilities.

WE'D LIKE TO TELL YOU MORE

Send for facts about our unusual skills and how other companies use them in defense weapons production. Write to Mechanical Div., General Mills, Dept. OD11, 1620 Central Ave. N.E., Minneapolis 13, Minn.

MECHANICAL DIVISION

Creative Research and Development • Precision Engineering and Production

General Mills

Herman Nelson

PORTABLE HEATING and VENTILATING

keeps men and machines at work

Van Heating, when a Herman Nelson portable heater was furnished as part of a mobile electronics van. Built right into the van, it exactly fits the needs of this new mobile unit.

Engine Maintenance is a must — even under severe winter conditions. With efficient portable heaters on the job, mechanics on this engine test stand are able to make necessary adjustments and repairs — impossible under usual sub-zero conditions. Instant portable heat solves the problem.

Space Heating, temporary or partially completed structures become usable when Herman Nelson portable heaters move in to furnish quick, unfailing heat. Serving the Defense Establishment everywhere is Herman Nelson's major task. Put 16 years of experience to work on your next portable heating or ventilating problem.

AAF

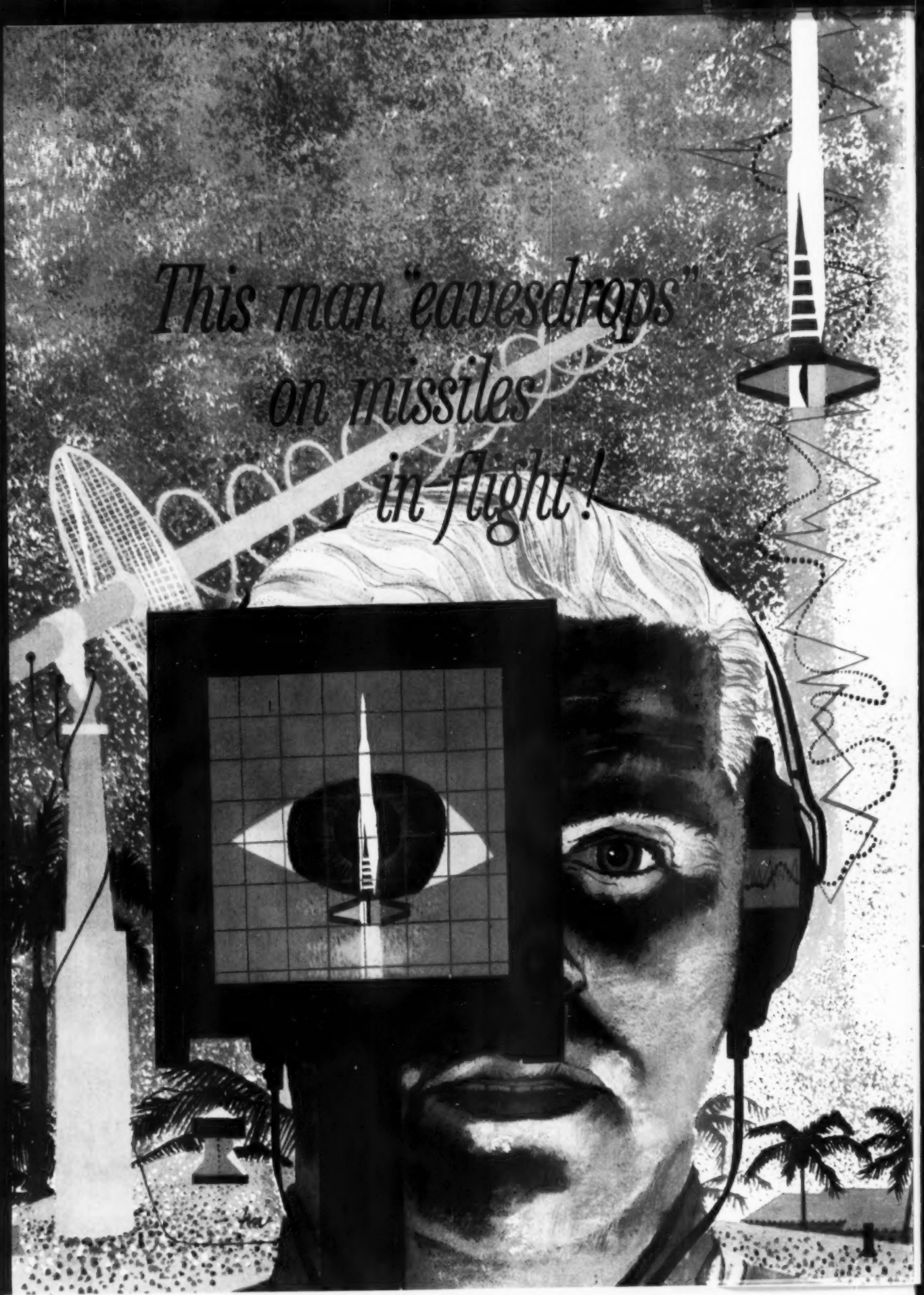
herman nelson

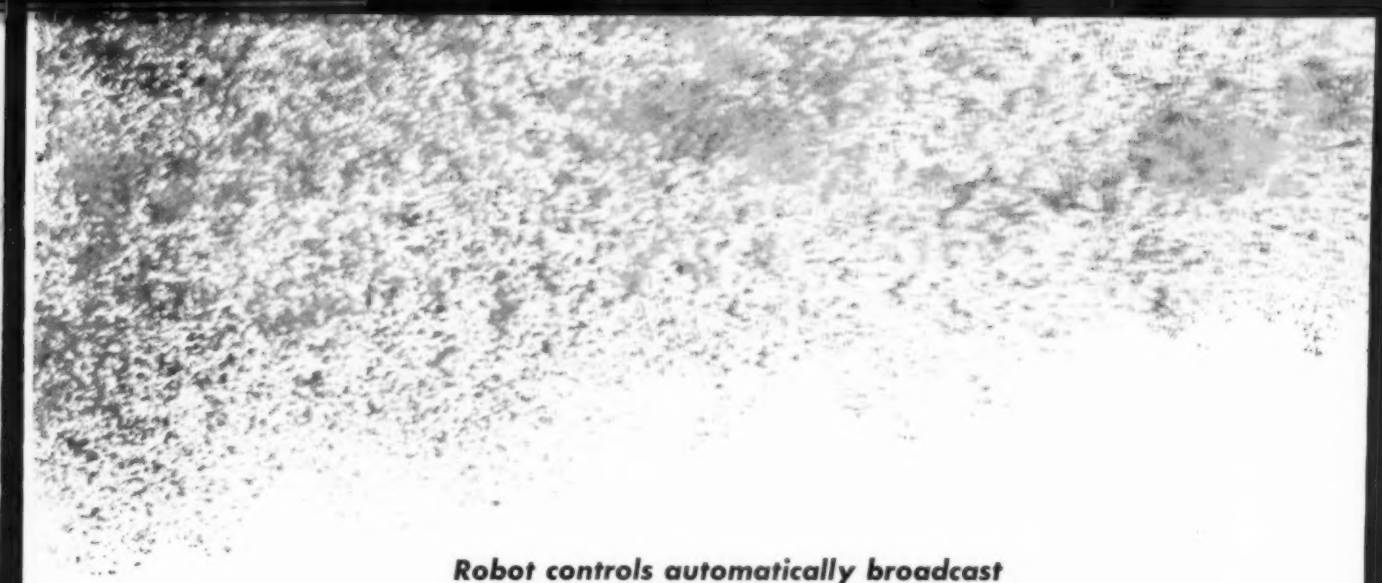
American Air Filter

COMPANY, INC.

Louisville, Kentucky

DEFENSE PRODUCTS DIVISION


This man "eavesdrops"
on missiles
in-flight!



Robot controls automatically broadcast

the technical data our scientists need to study the performance

of missiles flying at supersonic speeds

Where

AC

fits in this picture

At left you see one of a group of men who work in telemetry stations strung like beads in a line from the Florida coast far into the Atlantic.

His job—one of the world's most important. To measure with hairbreadth accuracy the performance of supersonic missiles in flight, as they slip past his position at heights beyond the vision of the human eye . . . at speeds almost beyond the comprehension of the human mind.

Every movement of the missile . . . every change of course . . . every correction of control is automatically broadcast to this man and others like him—and relayed back to a central control point where engineers and scientists wait to correlate the results and study missile performance.

This is the world of guided missiles. Not the world of tomorrow, but the world of today.

Where does AC fit in this picture?

The engineers at AC are an important part of the team, working with scientists in American universities, and officials in the ICBM, IRBM and "Air-Breathing" Missile Programs at the tremendous job of producing operational missiles.

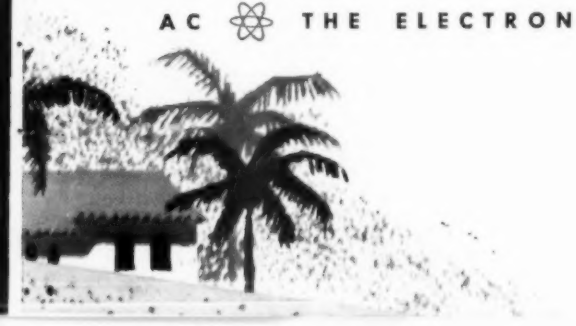
This team consists of men in the armed forces, and some of the best-known and best-respected names in science and industry. It is a tightly knit group of missilemen, small in number, but spread from Cape Canaveral, Florida, to M.I.T. . . . and from White Sands and Holoman Air Base in New Mexico to airframe factories from Los Angeles to Baltimore . . . and including AC's own electronics group in Milwaukee.

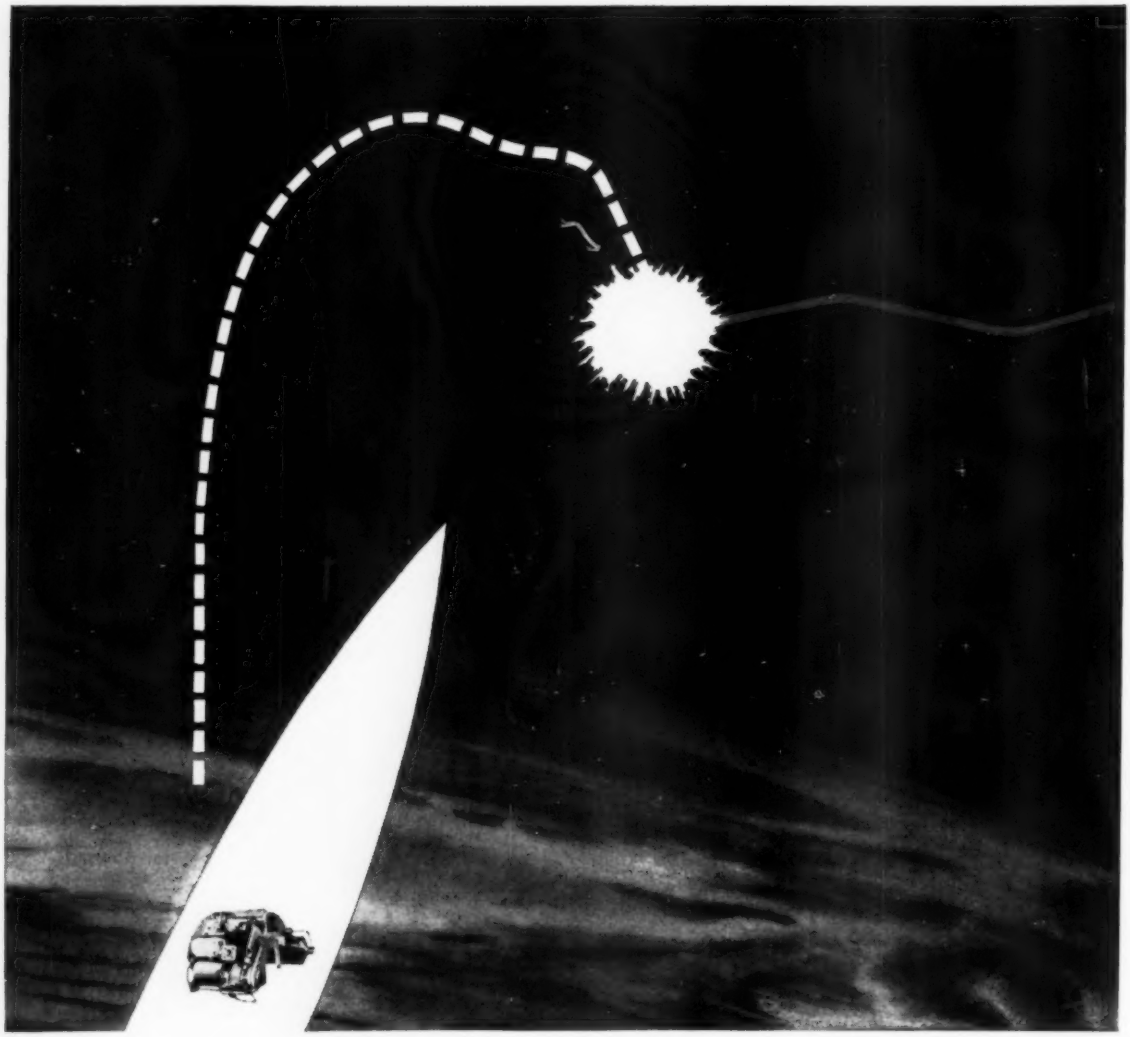
AC's part in this all-out program is to build an inertial guidance system which can direct a missile on its appointed course. The system—which AC calls the "AChiever"—has already proved its capabilities in both laboratory and operational tests.

It is entirely self-contained, guiding its missile to the target with fantastic accuracy, and with complete immunity to man-made interference—electronic, radar or infra-red.

If you are a graduate engineer and feel that you might be one of the missileman breed—and if you are not now a member of the armed forces—write or phone the personnel section of AC in Milwaukee. There may be a place in this vital program for you.

AC THE ELECTRONICS DIVISION OF GENERAL MOTORS





For the "killing" demands of accessory power...

AMF has experience you can use

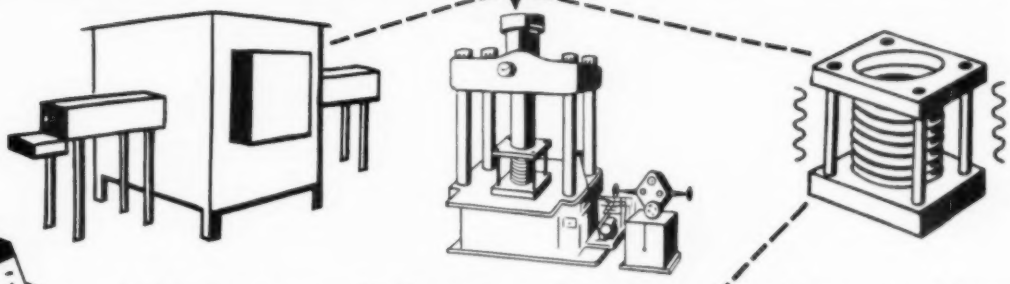
• No part of a missile is more important than the power supply that directs it to the "kill". And AMF has produced more gas turbine power units for guided missiles than any other source. • Typical AMF systems produce up to 50 hp.—with modifications, up to 200 hp.—at durations from 20 seconds to many hours. They are completely independent of the main power plant, insensitive to missile attitude or altitude, and to environment, acceleration, shock, or vibration. • Units offer multiple start-stop flexibility, precise frequency and voltage control, and can be packaged to fit practically any space arrangement, with little size and low weight. • See for yourself why, in accessory missile power as in a variety of other highly specialized fields, AMF has experience you can use.

- *Armament*
- *Ballistics*
- *Radar Antennas*
- *Guided Missile Support Equipment*
- *Auxiliary Power Supplies*
- *Control Systems*

AMF DEFENSE PRODUCTS

Defense Products Group
AMERICAN MACHINE & FOUNDRY COMPANY
1101 North Royal Street, Alexandria, Va.

Asbury Park • Atlanta • Boston • Brooklyn • Dallas • Dayton • Los Angeles • Seattle • Tucson • Washington, D. C.



Cold Press and Sinter or Hot Press or Vacuum Sinter!

25 Years of Powder Metallurgy EXPERIENCE FOR SALE!

THE PROBLEM — Industry and Government are engaged today in a gigantic effort to develop new alloys and stronger metals. The future security of America depends on the success of this program. Powder metallurgy, possessing unique advantages not common with any other process, can solve many of the tough metallurgical problems created by the jet age.

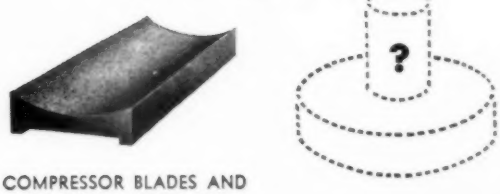
THE FACILITY — Metal Carbides, a pioneer in powder metallurgy, is well qualified by the experience of the past 25 years to help solve your particular problem. Our modern, well-equipped plants of over 100,000 sq. ft. are at your disposal, manned by skilled technicians and metallurgists capable of performing every technique known to powder metallurgy. Here are the facts:

THE PROCESS — Our equipment is varied and complete. Cold pressed and sintered parts can be processed in a vacuum or controlled atmosphere. Hot pressed parts can be produced up to 30" in diameter, up to 100" in length, and up to 5000 lbs. Other available processes include vacuum casting, centrifugal casting, hot forging and vacuum impregnation.

THE MATERIAL — Our experience covers the processing of carbides of tungsten, titanium, tantalum, molybdenum, chromium and columbium. Extensive experiments have also been conducted with various borides, silicides and oxides. Combinations of metals and ceramics have been developed which show great promise, and new possibilities seem unlimited.

THE ANSWER — Metal Carbides has found that by combining the best features of the above processes — with the right combination of metals and materials — totally new advantages result. Whether you require a structure that is porous, dense or tough — or a material that will withstand heat, corrosion or shock — let us put our experience to work helping you reach your objective! **Metal Carbides Corporation, Youngstown 7, Ohio.**

Send for new 84-page Catalog No. 55-G.



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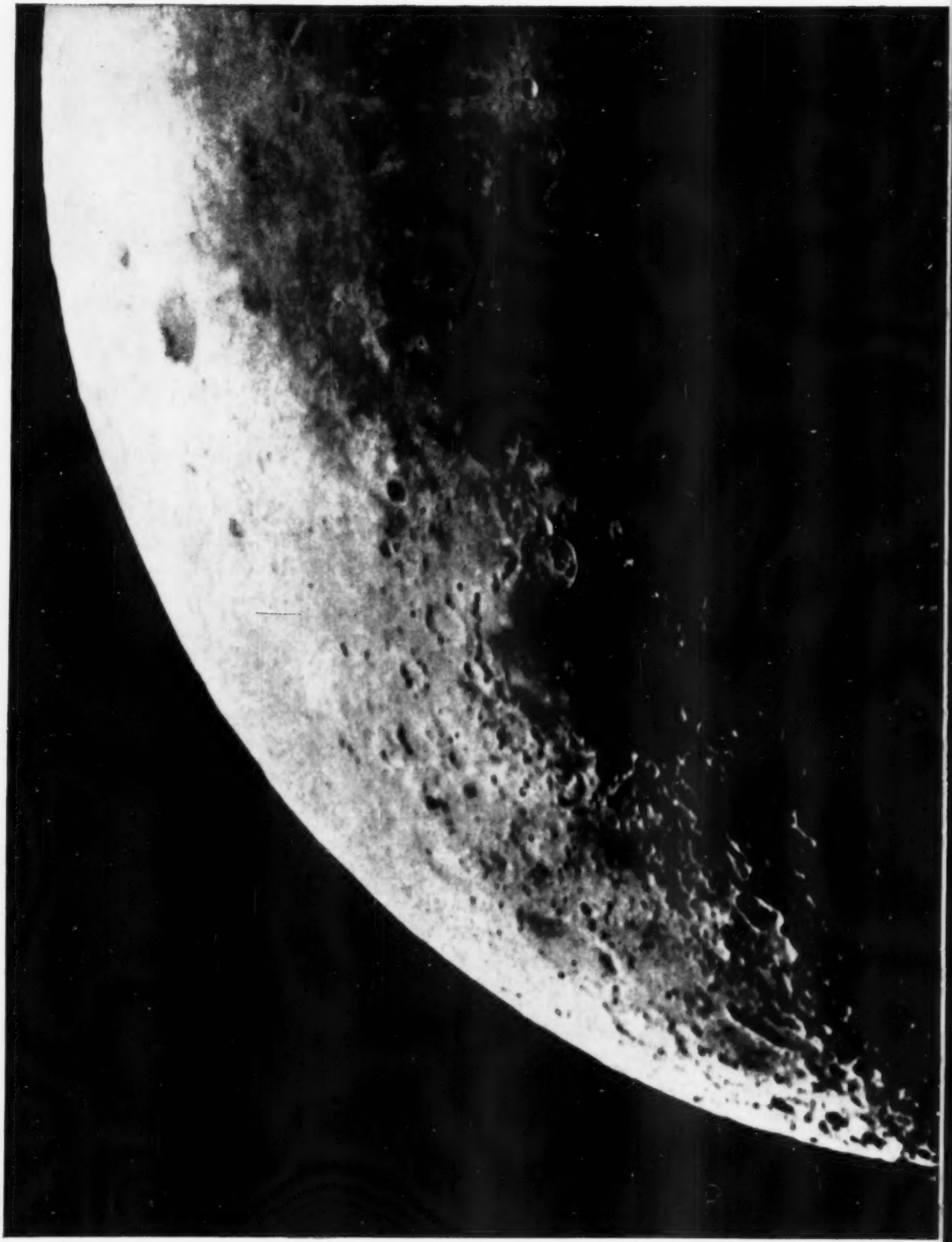


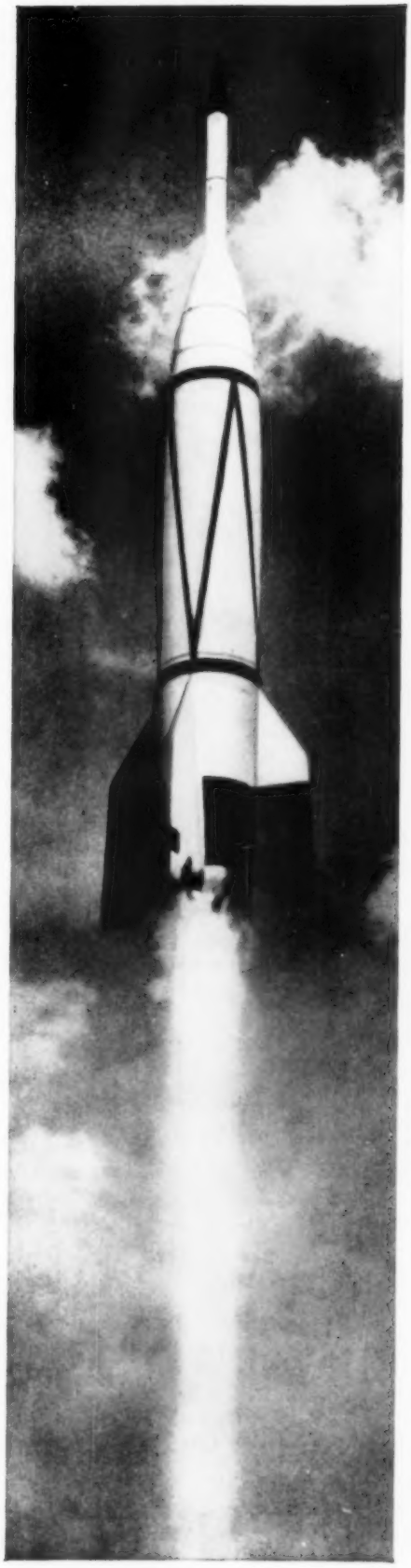
Lunar craters as seen through an astronomical telescope.
The puzzle of what's on the other side may soon be answered.

World's oldest mystery soon to be solved

Ever since man has had the imagination to ponder *any* problem, he has wondered what lay on the dark side of the moon . . .

Now, engineers predict that rockets carrying cameras or TV will circle Luna within five years and show us her other face.

At Douglas Aircraft, where one of the first rocket and missile projects was set up in 1941, practical investigations have helped show the way to lunar circumnavigation. They have led to more effective missile guidance systems . . . helped establish basic principles of air-to-air rocket fire . . . led to use of such heat-resistant materials as titanium, ceramics, and plastics. Douglas engineers have investigated *space physiology and psychology*—how man will react in the weightfree glare of space—and even investigated new kinds of power, engines that may use ions or light rays to reach the stars.



Wac-Corporal, an early Douglas rocket, takes off in the nose of a captured V-2 to set what was then a world altitude record. Douglas has since developed such weapons as *Nike*, the new *Nike-Hercules*, and the Army's potent *Honest John*, which can carry a nuclear warhead. Even more exciting projects—still classified—are going full speed ahead at Douglas.

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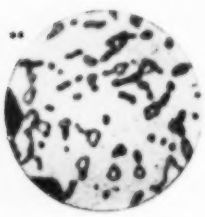

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PERRY PLASTICS IGNITERS AND BLOWOUT DISCS KEEP AIR FORCE JATO UNITS DEPENDABLE, SAFE

Heavy planes, like the B-47 you see in the Air Force photo, sometimes need help in getting off the ground. Short runways, added fuel, and extra striking power make an additional engine or two very desirable, especially for take-off. JATO—jet assist take off—does just that. For only one-tenth the weight each JATO unit gives the ship an extra engine during the critical moments of taking to the air.

Before JATO could be a success, many problems had to be solved. One of them was the development of an ignition system to set off the squib. This assignment called for a combination of talents. Needed were experience in precision metal working, knowledge of dielectric plastics, design and manufacture of an electric harness to be housed in a large screw-machine piece. Finally, the assembling of a finished product that could give accurate ohm resistance even under great hydrostatic pressure.

But this was only part of the requirement. Something else was needed—a blowout assembly. After igniting, a JATO tank can become a live bomb unless a safety valve is built into it. We're proud to say that, on both counts, Perry delivered in full and on time.

If you're looking for a complete plastics manufacturing facility, check on Perry. We're staffed and equipped to work in thermoplastics, thermosetting, fiber-glass lamination and molded expanded polystyrene.

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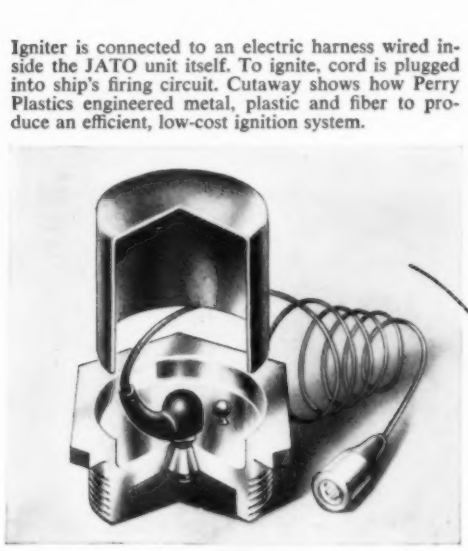
Air Force Photo shows B-47 getting boost from JATO units. At lower left you see cut away view of igniter; center, JATO unit, and right, cut away of Blowout Tube Assembly made by Perry Plastics of Erie.

Igniter is connected to an electric harness wired inside the JATO unit itself. To ignite, cord is plugged into ship's firing circuit. Cutaway shows how Perry Plastics engineered metal, plastic and fiber to produce an efficient, low-cost ignition system.



Cutaway of Safety Blowout Assembly. Tolerances for this safety valve are very narrow. The disc will rupture on a variation of 50 pounds pressure plus or minus. Perry Plastics has delivered over half a million of these valves.

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Missiles use steel to contain and direct the terrible pressures and temperatures generated by their fuels. That's why an experienced steel fabricator like ALCO—intimately familiar with the problems imposed by steel — makes the best possible prime or subcontractor for missile hardware.

ALCO's steel-fabricating experience goes back more than 100 years and includes steam locomotives, many types of heat exchangers and pressure vessels, nuclear components and other items with problems similar to those encountered in missiles. ALCO engineers fill important committee positions in technical societies devoted to steel's metallurgical and welding problems. ALCO even produces steel at one of its plants to insure the top quality of its forgings and flanges.

Production for defense at ALCO has included medium tanks, gun-recoil mechanisms and many other items, both on prime and subcontract. The combination of this experience in defense contracts and steel know-how is now at work producing the Army Honest John artillery rocket, components for the Air Force Snark and Navy Terrier missiles, and Talos launchers for the Army.

Investigate ALCO's capabilities for missiles. Seven plants in five states, over $50 million inventory of machine tools for steel fabrication.

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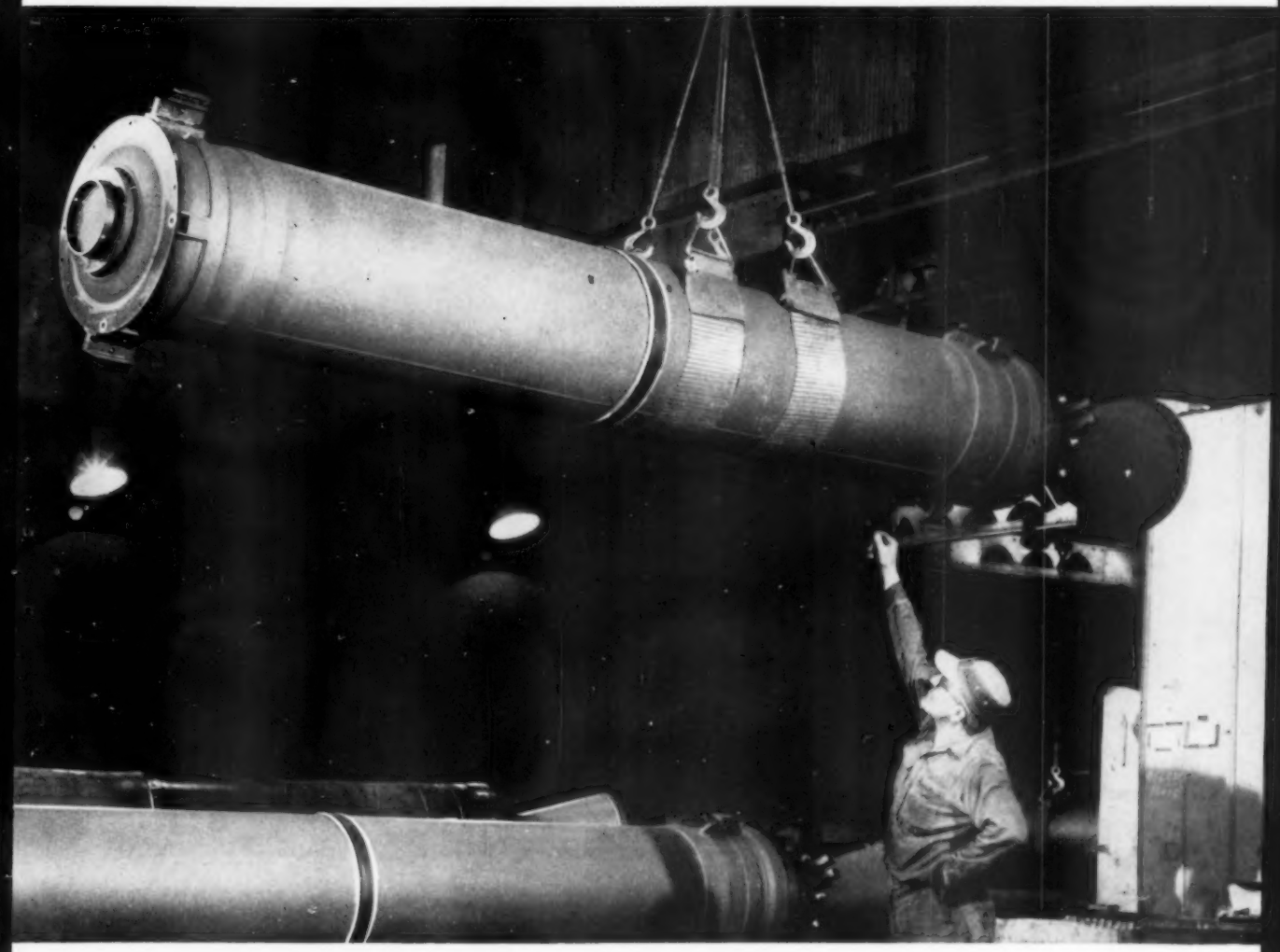
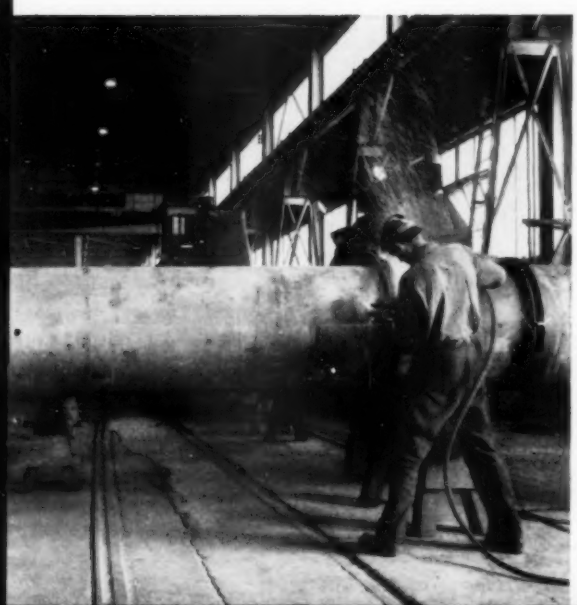
AIR FLASK for Terrier missile was produced under subcontract by ALCO at its Auburn, N. Y. plant. Unit supplies pressure for missile functions other than propulsion. Production required extensive steel metallurgy testing, and super-accurate machining and finishing.

EXPERIENCE WITH STEEL



MAIN BIRD of Honest John artillery rocket is now produced in quantity by ALCO under prime contract. Steel unit posed problems in metallurgy, plate-rolling and welding familiar to ALCO from its experience with pressure vessels.



ROCKET BOOSTER for Snark is similar to Honest John rocket, provides take-off boost for missile, is dropped later. Exhaust is angled downward to provide lift from gases. ALCO makes unit of steel under subcontract.

ALCO's capabilities for missile production are outlined in a brochure, "What does it take to make a missile?" For a copy, write Defense Products, Dept. ON-2, P. O. Box 1065, Schenectady 1, N.Y.

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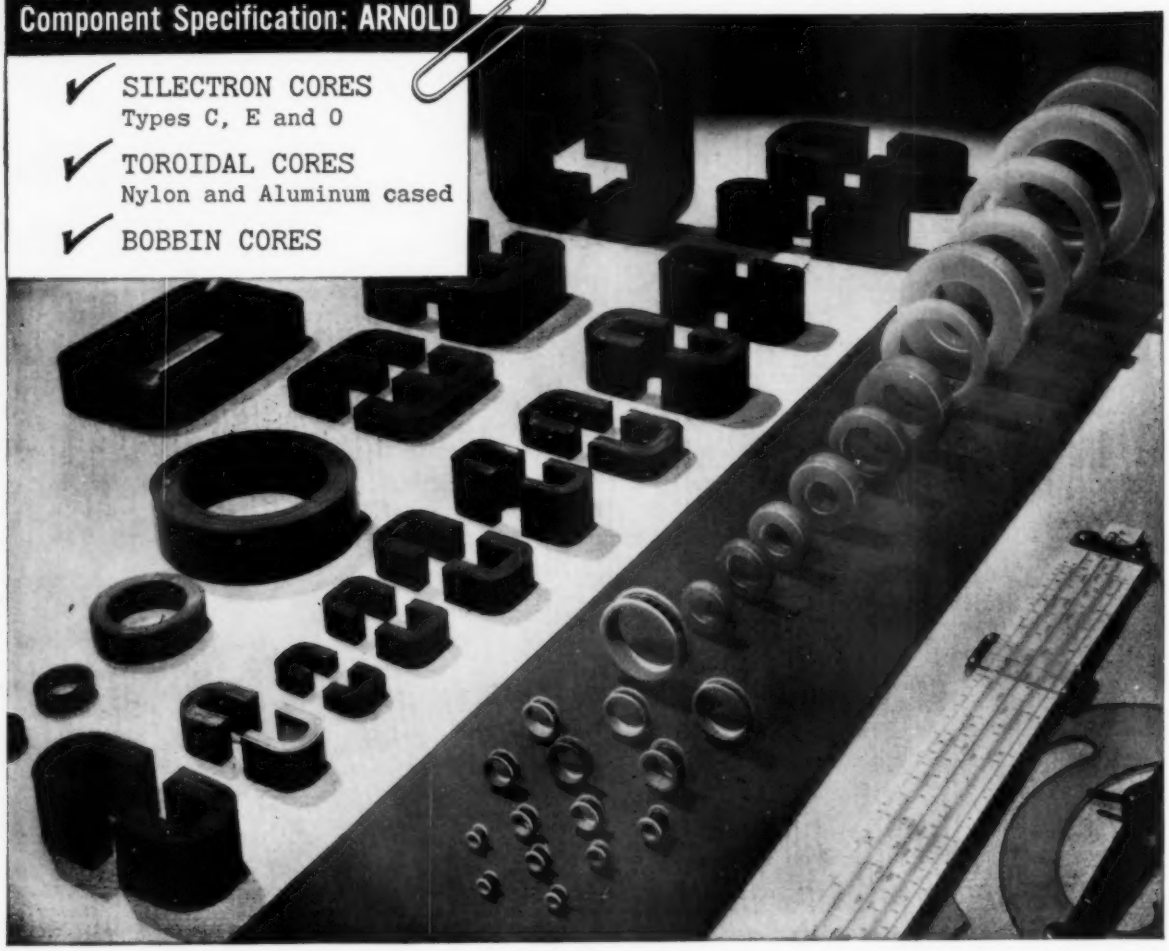

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For data on the various types of Arnold Tape Cores, write for these Bulletins:

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TC-101A—Toroidal Cores, nylon and aluminum cased
TC-108A—Bobbin Cores

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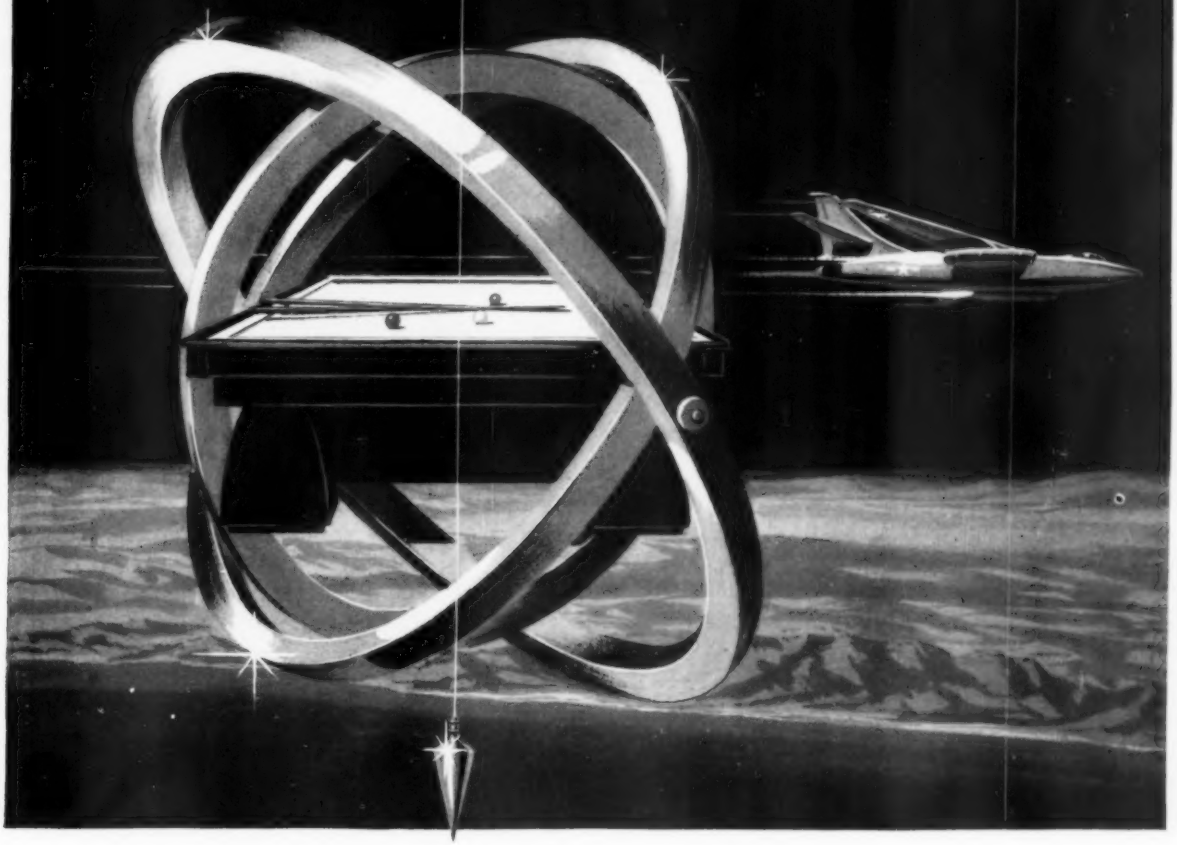

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This system was developed in Admiral's Palo Alto Laboratory by the Advanced Development Section, Government Laboratories Division. Complete information concerning the Laboratory's capabilities and current activities is available to qualified persons.

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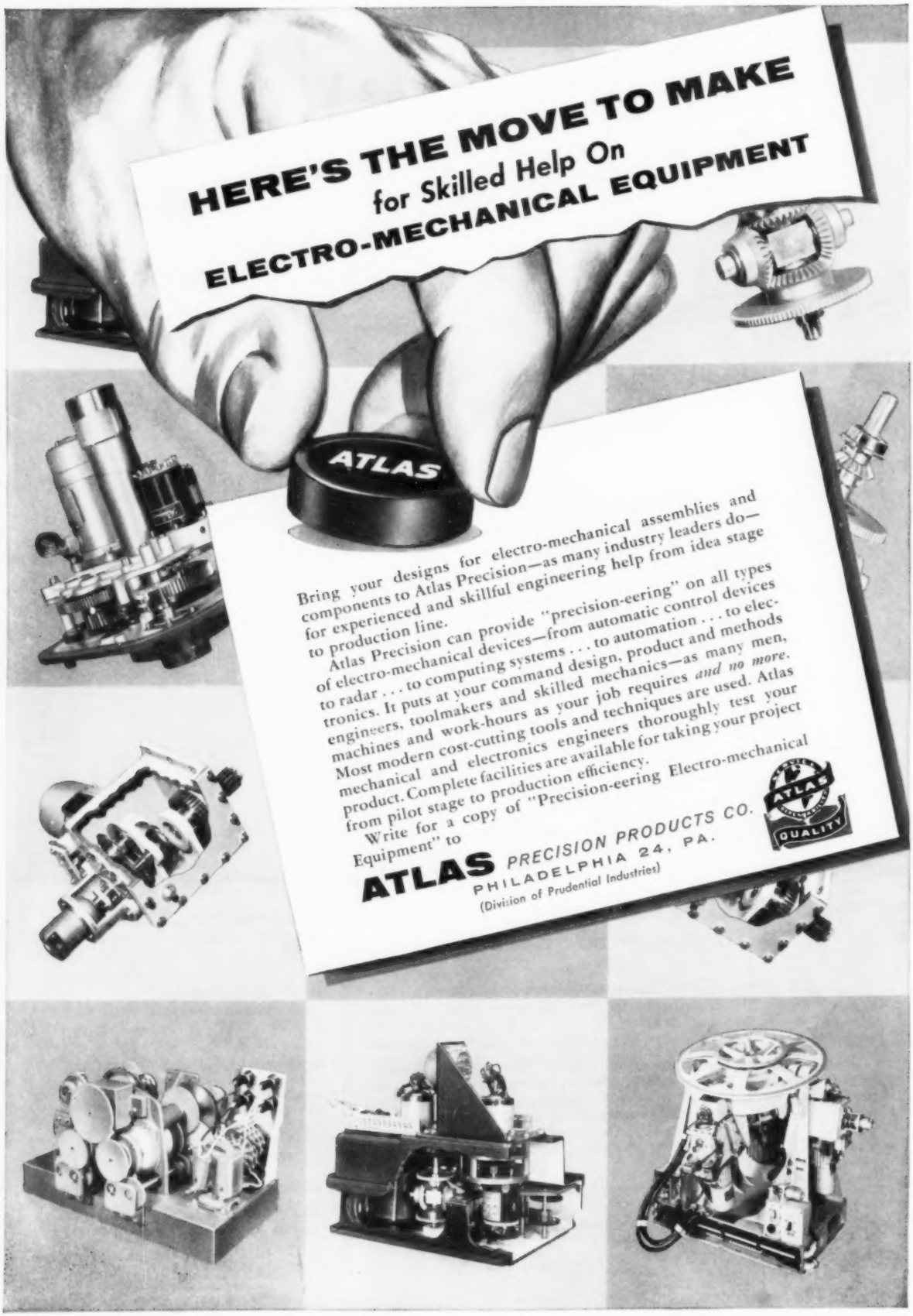
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- ✔ **Uniform high quality propeller shaft tubing. Steel made to our exacting specifications.**
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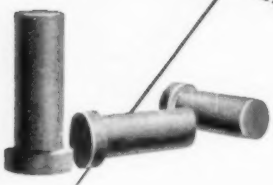

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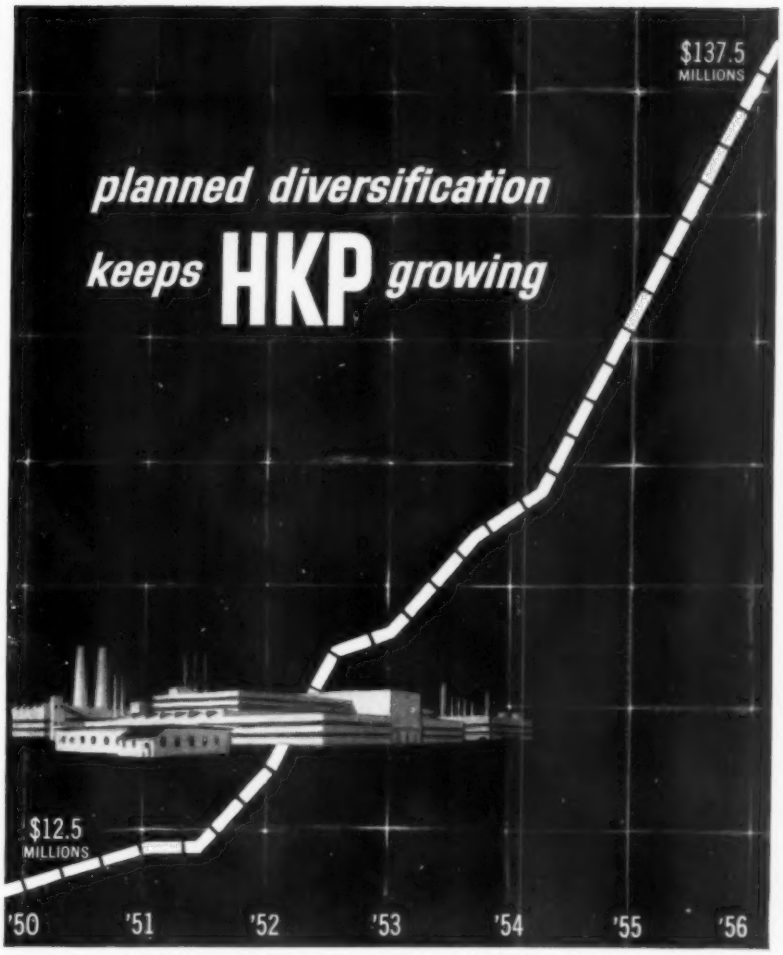

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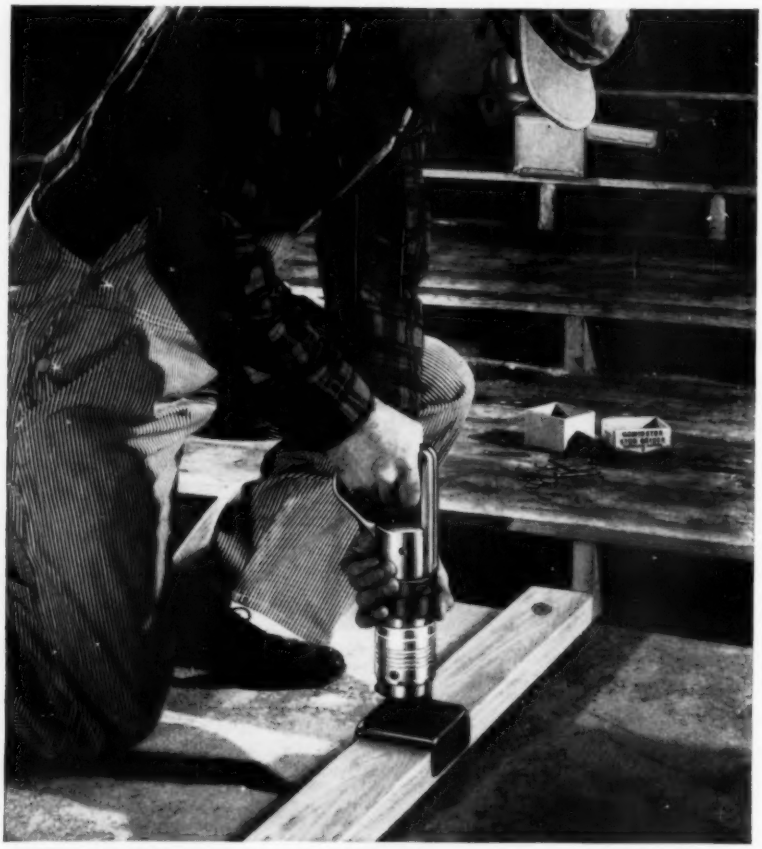

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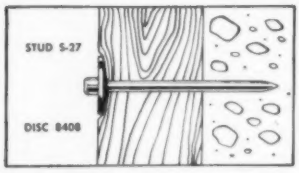

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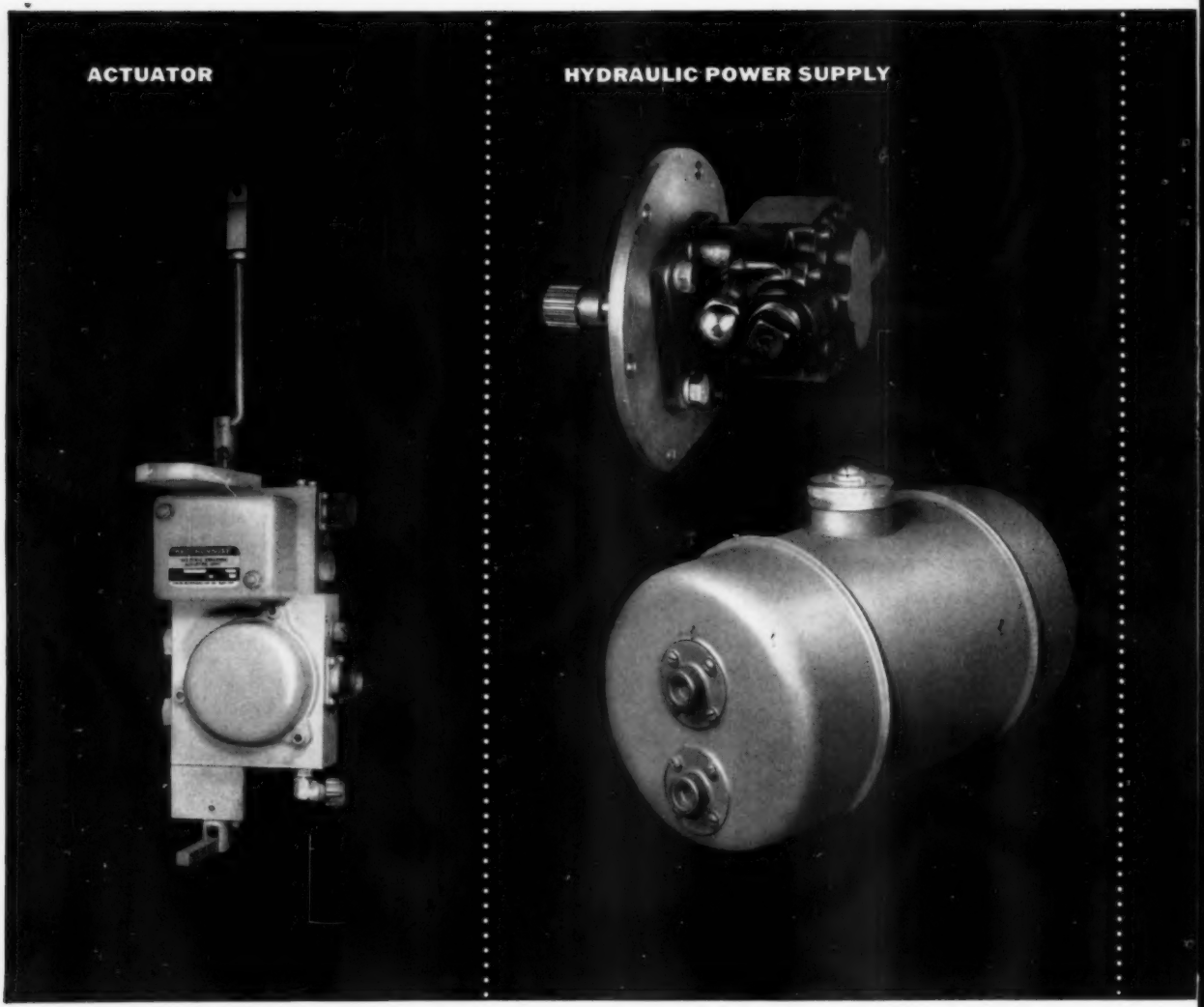

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Lockheed's F-104A Starfighter, newest weapon of the Air Force, is the most advanced airplane of its type. To give them the greatest possible resistance to extreme conditions, bearing surfaces *(arrows)* of hot air valves used in the F-104A are Flame-Plated with tungsten carbide. Flame-Plating provides the wear-resistant coating needed to withstand the high unit loading and temperature extremes jet plane parts undergo.

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Flame-Plating is LINDE's special process for protecting metal parts from wear, abrasion, and fretting corrosion. Tiny particles of tungsten carbide or aluminum oxide are literally *blasted* onto the metal surface. Since the temperature of the part being coated seldom exceeds 400 degrees F., there is little or no risk of changes in its shape or metallurgical properties. Flame-Plated coatings can be applied from .002 to .010 inches thick, and used as coated or finished to 0.5 microinches rms. Practically all metals can be Flame-Plated—aluminum, magnesium, molybdenum, titanium as well as copper and steel.

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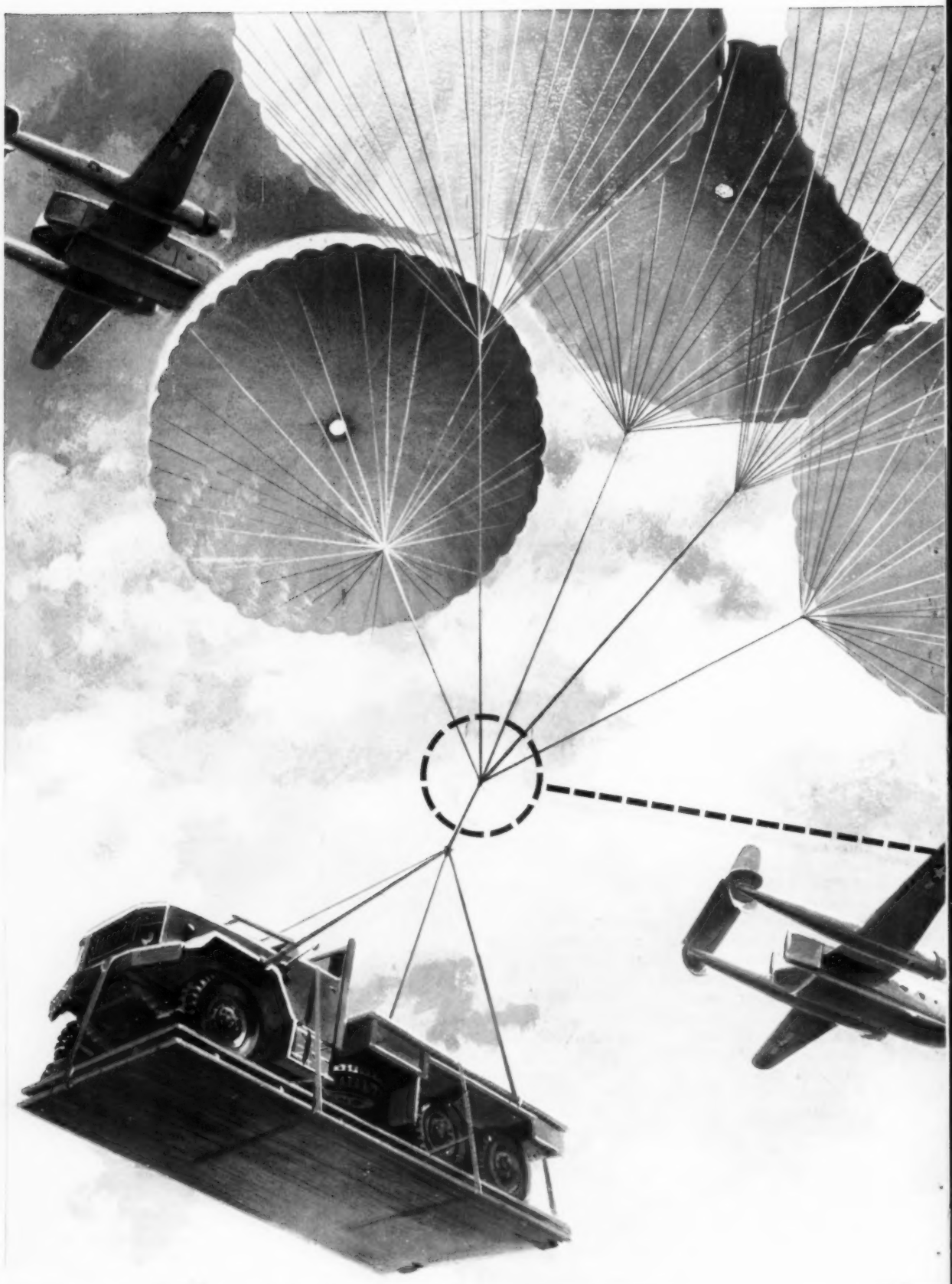

Hidden hands shoot the chutes with the help of Flynn aluminum extrusions

The mechanical "helping hand" that automatically opens the cover of these parachutes is a fascinating explosive-powered device engineered for production by Ordnance Specialties Company, El Monte, California.

An important part of the job for Ordnance Specialties design men was the selection of materials for this vital 'chute-opener. Tolerances were small. Cargo was precious. Lightweight aluminum was indicated for the cylinder casing.

Ordnance Specialties engineers chose Michael Flynn to produce the dimensionally critical extruded aluminum casing. Flynn's twenty years of aluminum-working experience paid off for Ordnance Specialties and for the Government. Flynn had the know-how that assured their getting the metallurgical characteristics and close adherence to specifications so necessary to this job.

When it comes to dependable-quality aluminum extrusions, depend on Flynn. When stock or custom shapes are needed, depend on Flynn. And, when technical assistance is needed, depend on Flynn. Rely on Flynn, too, to maintain tight production scheduling and for prompt delivery.

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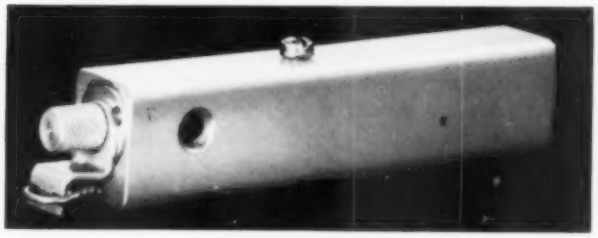
Parachute shroud-cutter, pictured one-half actual size, contains a variable number of pellets that burn at the rate of two seconds each. The last pellet ignites an explosive charge that propels the shroud-cutting piston. To the left is a profile of the Flynn aluminum extrusion that forms the cylinder casing of the "hidden hand" that shoots the chutes.



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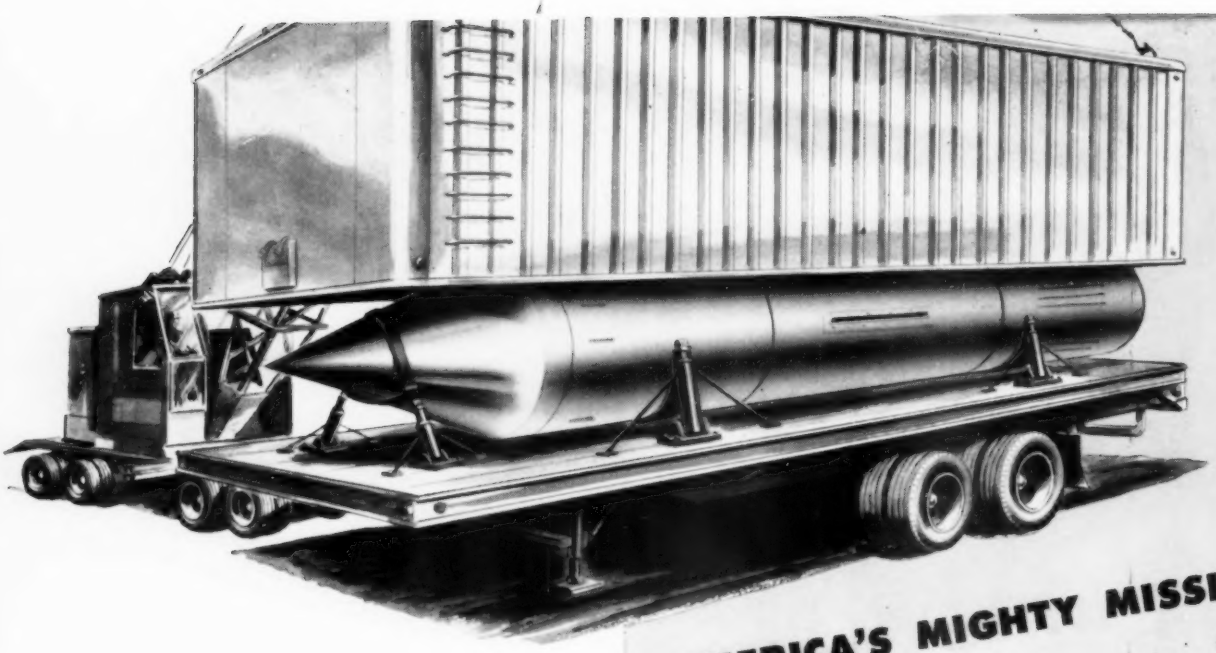

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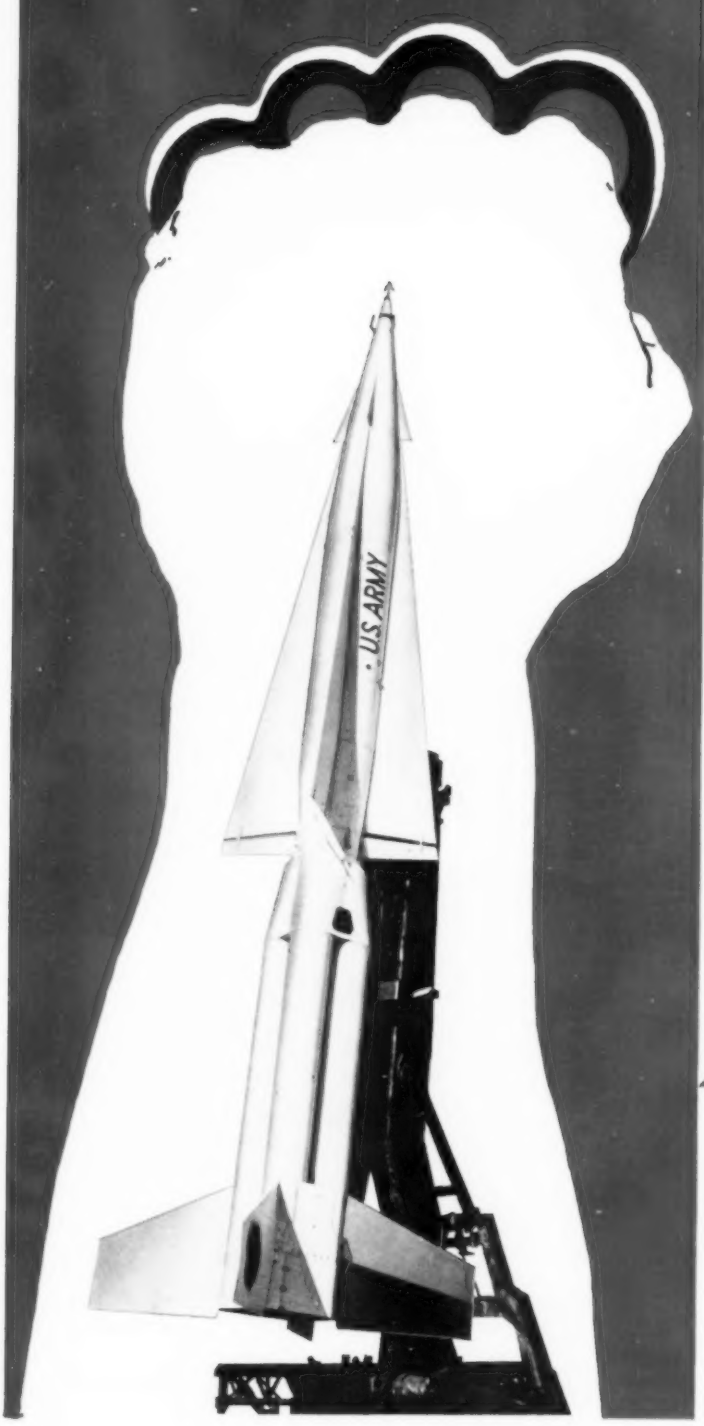

An Army missile with a lethal wallop, the Nike-Hercules will deliver a knock-out blow to enemy air aggression—Sunday and every day, around the clock. Nike's knuckle-duster is its warhead—loaded and tested, developed and delivered by Aerojet-General's Explosive Ordnance Division.

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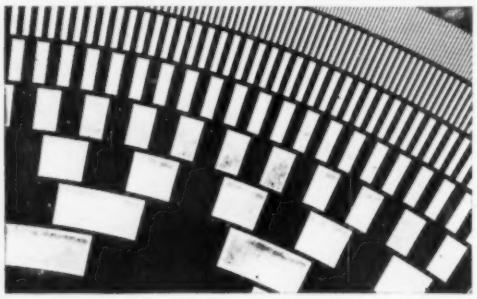
Gurley Standard Binary Code Discs Now Available in Four Versions



Gurley, manufacturer of the *standard* binary code disc for the electronics industries, is now able to supply four versions for use in either photo-electric, magnetic or contact types of pickups.

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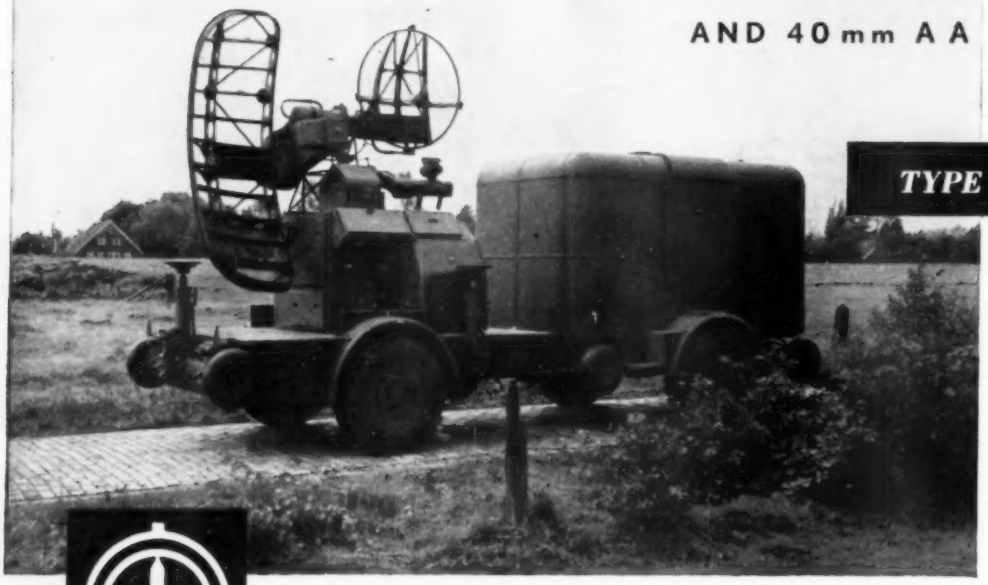

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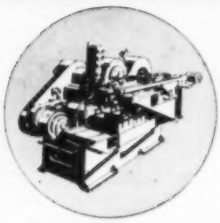

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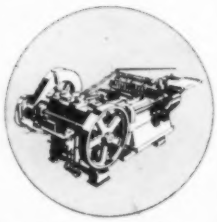

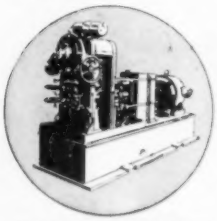

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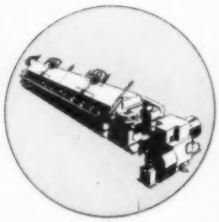

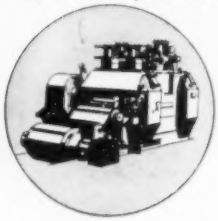

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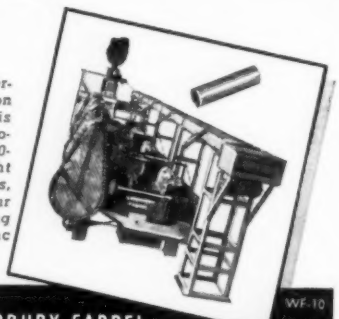

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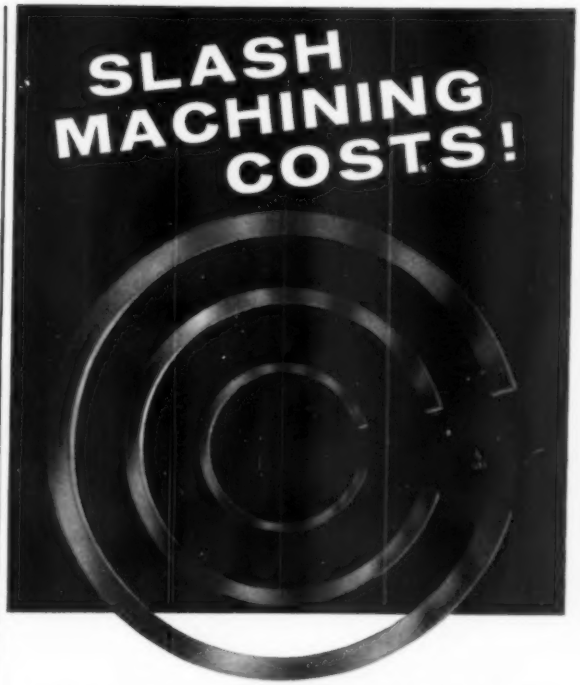

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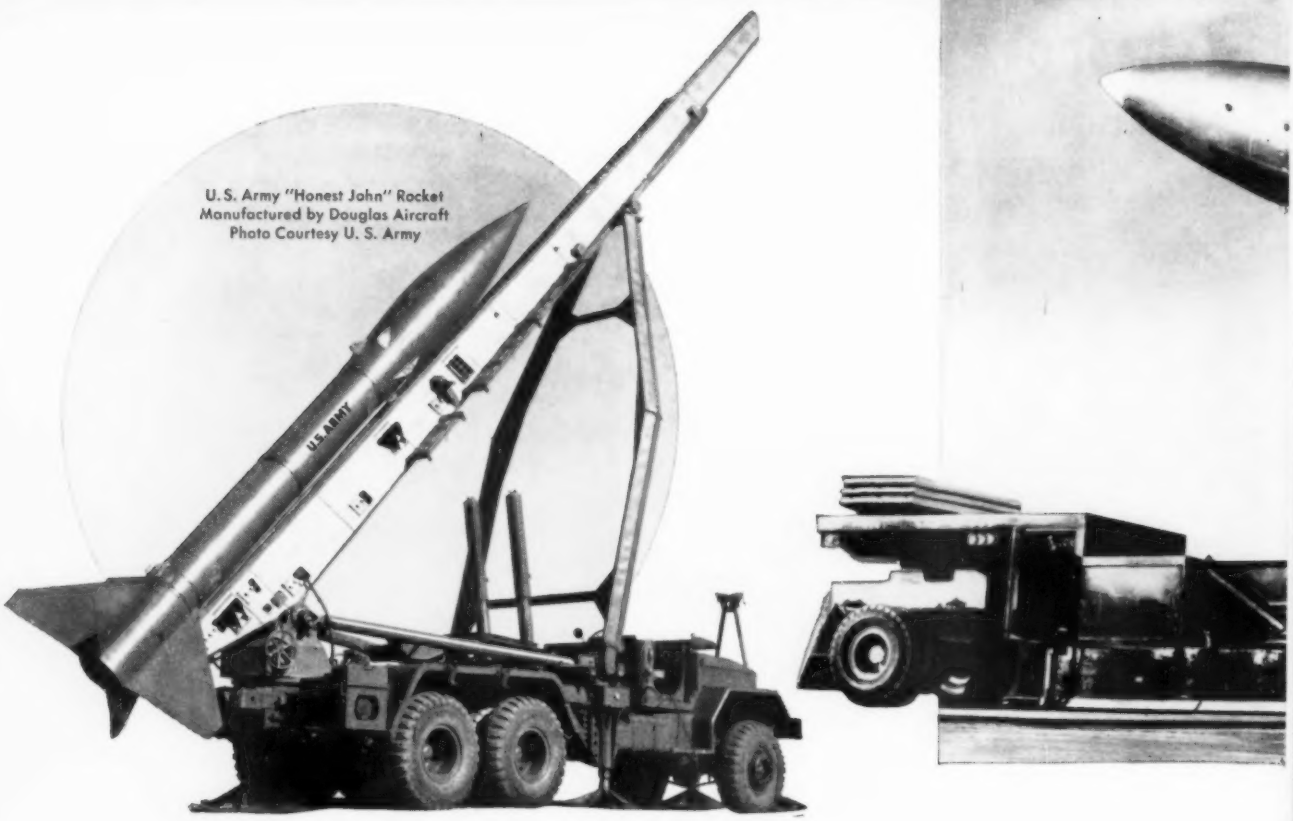

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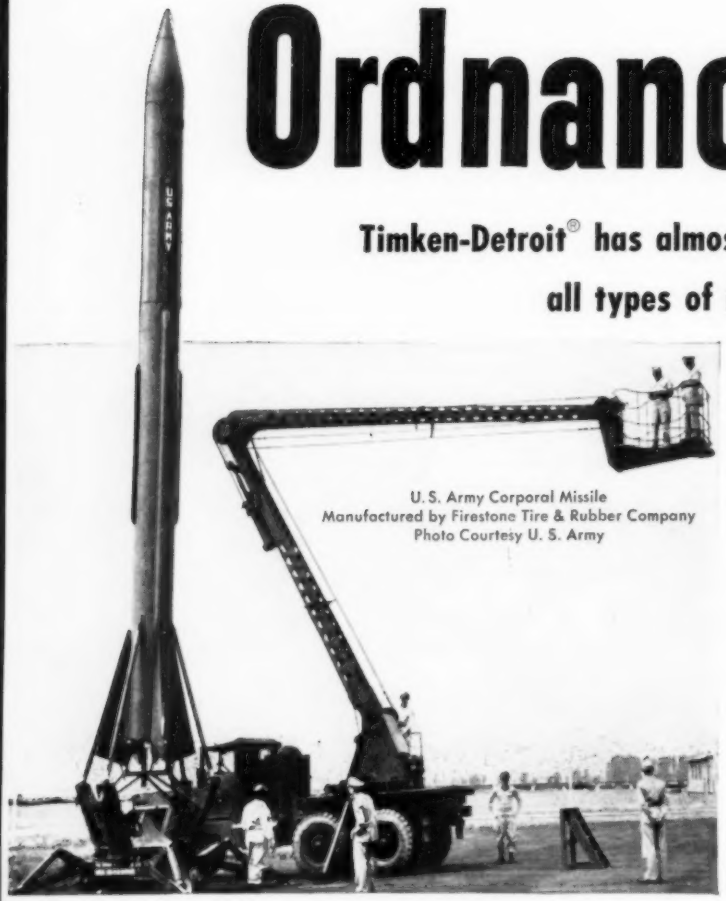

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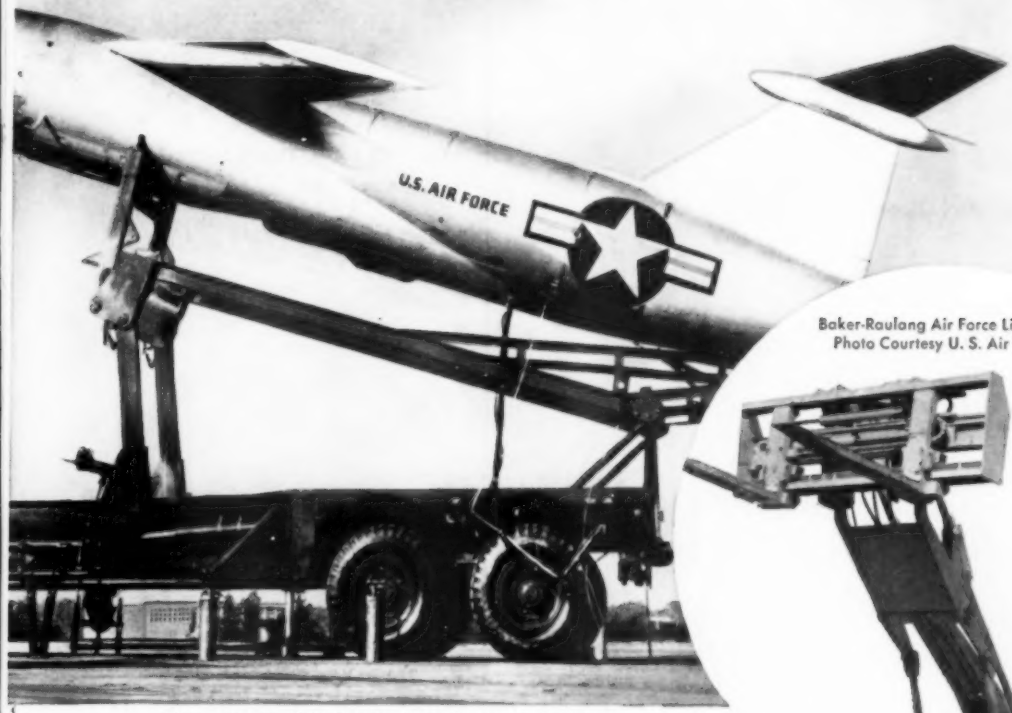

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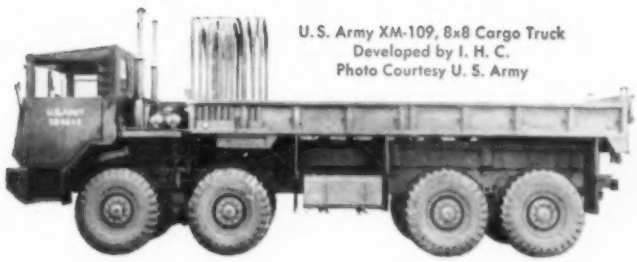

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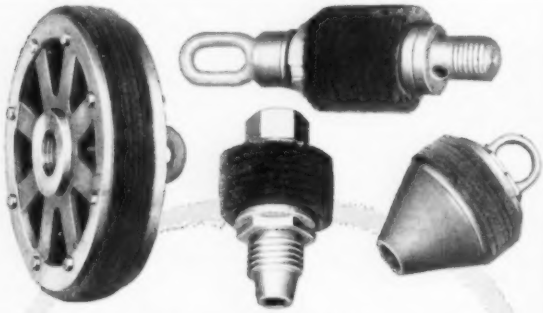

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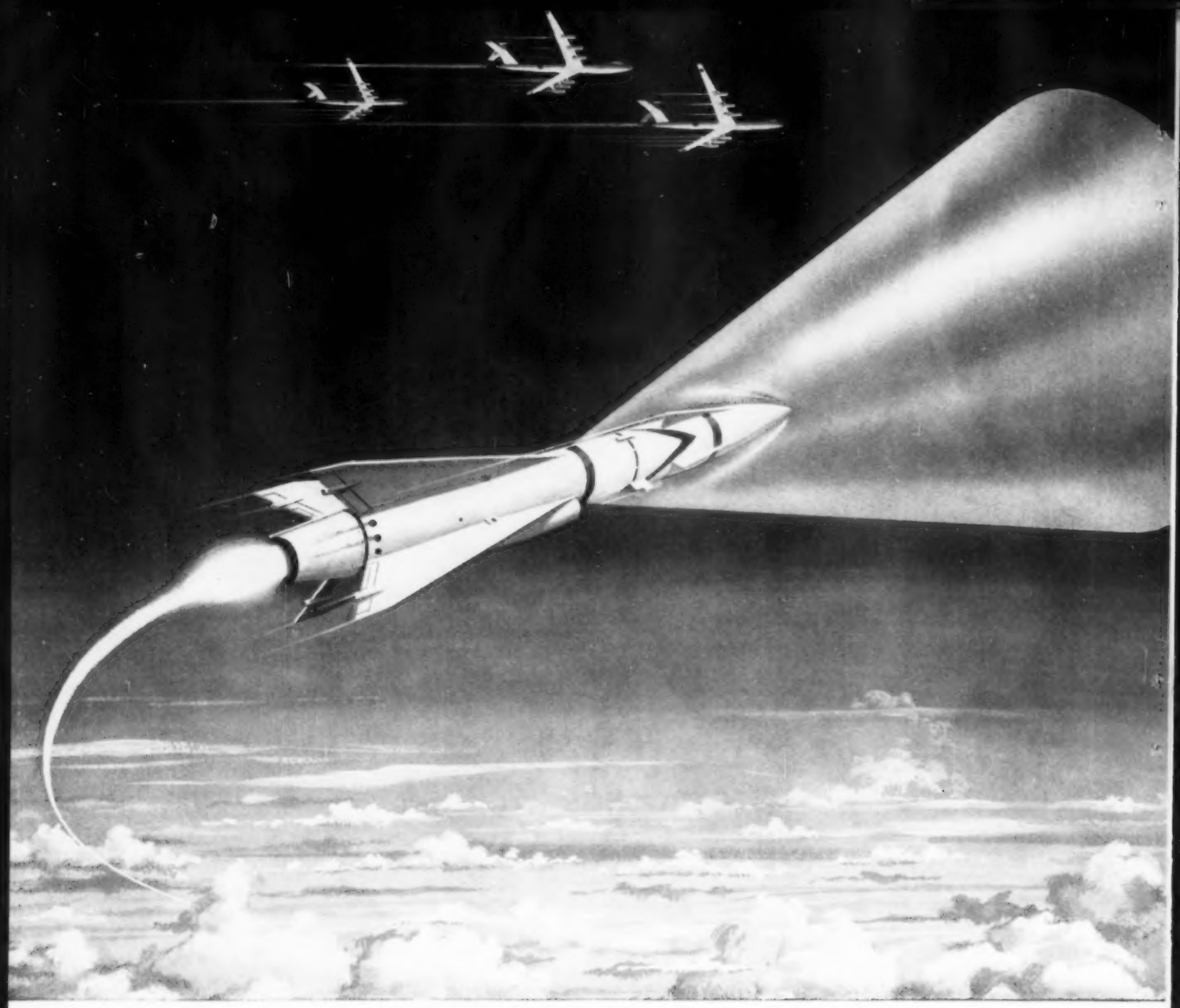

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FIREPOWER

This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Committees of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

High-Energy Fuels

New boron compounds may surpass present liquid hydrocarbons

D. R. Geehring

Aeronautical engineer, Flight Propulsion Laboratory, General Electric Company, Cincinnati, Ohio

HIGH-ENERGY fuels are receiveiving a great deal of attention in newspapers and technical magazines. According to reports, the aviation industry is eagerly awaiting the emergence of these new chemical fuels to provide state-of-the-art advancements in the next generation of aircraft and missiles. Important implications to ordnance are rumored.

A recent news release upon the occasion of ground breaking for a new exotic-fuels plant caused a sharp rise in the stock of the heavy chemical producer involved. Several prominent government figures have likened the present state of high-energy fuels to the birth of the oil industry many years ago. Are all these glowing prospects justified? What are the real odds for the success and the future market of high-energy fuels?

BEFORE these questions can be answered, a basis for comparison and evaluation must be established. Perhaps the first consideration should be to define a high-energy fuel. Unfortunately, this is not simple. The familiar gasolines and kerosenes of various grades and our aviation jet fuels all have heating values of 18,000 to 19,000 British thermal units (Btu) per pound, which is considerably more than coal at 14,000 Btu per pound.

For some applications, the energy per unit of volume or the specific impulse (a measurement of rocket thrust) may be more important. However measured, the high-energy fuels receiving greatest publicity are for use in air-breathing engines primarily, rather than rockets. These new fuels have heat energies *at least* a third greater than present liquid hydrocarbon fuels. Much higher values are known. Hydrogen, for example, has 51,250 Btu per pound—nearly three times that of gasoline.

AN aircraft engine is a device for accepting the stored energy in the fuel and transforming it into thrust to produce motion. Clearly, if more stored energy can be carried aloft in each pound or gallon of fuel, and if the engine can utilize it effectively, aircraft and missiles should benefit in performance. The most obvious benefit is improved range. Figure 1 illustrates typical burning characteristics of high-energy fuels. To reach the same temperature in an engine, less fuel is needed. If the same total fuel load is carried, greater range will result.

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The Army's Hawk guided missile blasts its way toward the target.

A flight of jet-propelled Navy Cougars operating from the deck of the U.S.S. MIDWAY make a practice run during recent maneuvers in the Mediterranean (Navy photo).

Alternatively, less fuel might be carried to provide the same range as hydrocarbon fuel. In this case, much smaller aircraft and missiles would be required, but these weapon systems would have very superior speed, rate of climb, and altitude. These advantages are shown in Figure 2. Reduced size of missiles to be carried on airplanes or submarines would enable our forces to increase their striking power greatly.

The high-energy fuels are inherently extremely reactive. They burn more vigorously and at higher rates under adverse conditions at high altitude where present jet fuels sputter and flame out. In the continual push for higher speeds at higher altitudes, the new fuels will find a ready market.

AT the present time none of the super fuels is ready for this market. Within the limits of military security it is possible to assess roughly the status of those materials whose existence has been officially acknowledged.

The boron fuels, developed under the Navy's Project Zip, are going into limited production. Both the Callery Chemical Company and the Olin Mathieson Chemical Corporation are building tonnage output plants for the Navy and Air Force respectively. These plants will cost in the vicinity of $35,000,000 each and are expected to go "on-stream" in early 1959. Prior to this date, several smaller plants will supply interim quantities of boron fuel.

The initial output of these plants will be devoted to an intensive, closely coordinated effort by both the Navy and the Air Force to develop engines for aircraft and missile operation. The use of "Zip" fuel poses engine problems—how to enable the engine to operate properly in an atmosphere of finely divided particles of boric oxide in air, particles which may change from gaseous to liquid to solid as they pass through the engine. Immediate service use of the "Zip" fuels cannot reasonably be expected, therefore.

Hydrogen is a sensational fuel. Although there has been little information released to the public, it is possible to speculate upon its position in the family of high-energy fuels. It burns with great alacrity as evidenced by the tragic fate of the HINDENBURG. Yet the very quality of lightness which made it useful in dirigibles represents the major obstacle to its use in heavier-than-air vehicles. The entire volume of the HINDENBURG, 7,000,000 cubic feet of hydrogen gas, would be consumed by a supersonic jet engine in less than five hours.

TO reduce the volume of this fuel to a practical size for aircraft, it must be carried as a liquid. To maintain hydrogen as a liquid requires a temperature of minus 432 degrees Fahrenheit, and even at this temperature liquid hydrogen weighs only about a tenth of an equal volume of gasoline.

In contrast to the "Zip" fuels where engine problems predominate, hydrogen presents some challenging design problems to the aircraft designer—problems of structure and aërodynamics.

The Navy's Regulus guided missile is fired from the submarine TUNNY during recent tests. The versatile missile has also been launched from carriers and land bases.

Armed with Falcon air-to-air guided missiles, the F-102A is a deadly aërial weapon.

With its stubby 7½-foot wings the Air Force's supersonic F-104A Starfighter demands great power from its turbojet engine (Air Force photo).

The supersonic Talos surface-to-air guided missile is shown during test flight (Navy photo).

Further still in the future are such concepts as free radicals—charged particles which release great energy by recombination rather than combustion. Although such fragments have been known to exist for many years, only recently has it been possible to isolate and store minute quantities of free radicals for examination. If such present-day curiosities could be stored in quantity as fuels, permitted to recombine, and then burned, it is conceivable that energies *ten* times that of gasoline could be released. In this field we have far to go, indeed.

There has been some recent interest in slurry fuels—suspensions of metal powders in jet fuels—but these are more properly classed as high-density fuels and appear to have extremely limited application at the present time.

THE present enthusiasm for high-energy fuels has come about largely as a result of the Navy's farsighted reach for the future known as Project Zip. This project, begun in 1952 under sponsorship of the Navy's Bureau of Aëronautics, was an intensive search for a practical high-energy fuel, for methods to produce such a fuel, and for the development of engines and weapon systems to utilize the fuel—if found. Project Zip focused intensive effort on research in boron chemistry.

Starting from the known boron hydrogen compounds of diborane, a toxic gas, and pentaborane, an extremely toxic liquid which is spontaneously flammable in air, new compounds were sought which could be handled in a practical manner and yet would retain the high-heating value of the original boron hydrides. The Callery Chemical Company, Pittsburgh, and the Olin Mathieson Chemical Corporation, Niagara Falls, became the Navy's prime contractors in this effort. At the peak of research, twenty-one commercial subcontractors and forty-three universities were engaged in work under Project Zip.

Millions of dollars were poured into this effort, and a technical breakthrough was made. Both contractors, using different methods, discovered a new series of compounds containing carbon in addition to boron and hydrogen. These compounds were more stable, less toxic, and had a higher density than their predecessors. These were the Zip fuels. Today, more refined versions of these fuels are being developed in pilot plants designed to explore production processes for the larger plants to come.

TO support the objectives of Project Zip it was necessary to determine the availability of the principal raw material, boron ore. An extensive program of drilling, mapping, data research and evaluation has been conducted since 1952 by the United States Department of Interior Geological Survey, under Navy Bureau of Aëronautics sponsorship.

As a result of this work both in this country and abroad, it is estimated that over 75 per cent of the world's economically recoverable reserves of borax,

Powered by an air-breathing jet engine, the Air Force Snark SM-62 is an intercontinental strategic guided missile capable of carrying a nuclear warhead (Air Force photo).

and other boron ores are located in the California-Nevada desert. These reserves are adequate to supply the Zip fuel program for many years.

The Air Force, too, was interested in high-energy fuels. In 1955, when additional financial support was needed to finance the rapidly expanding construction program, the Air Force actively entered the field. Today the Navy and Air Force are equal partners in the effort to utilize this new source of energy in the defense of our country. The closest coördination and harmony exists between the two services to avoid duplication of effort and to ensure maximum economy of precious technical manpower. This, in turn, automatically provides the maximum value for every tax dollar spent.

THE two prime contractors in developing boron fuels, Callery and Olin Mathieson, their subcontractors, and the universities have widened the horizons in many areas of chemistry and chemical engineering. New products and new applications for existing products are appearing continually as a by-product of the work on boron fuels. For example, several by-products of fuel manufacture show promise in the field of ordnance for possible use as charges, igniters, or solid propellants. In addition, a growing reservoir of technical talent is being developed which will aid in solving new problems of science and engineering in other fields.

Government scientists, too, have made outstanding contributions to the development and utilization of high-energy fuels. The National Advisory Committee for Aëronautics (NACA) at the Lewis Flight Propulsion Laboratory, Cleveland, Ohio, has conducted most of the combustion research and engine development testing to date. Very significant advances have been made using extremely limited amounts of available fuel. The NACA will continue to play a leading rôle in providing the engine manufacturers with research data for successful engine developments.

The National Bureau of Standards has maintained a continuing program of support in the basic sciences of physics, chemistry, thermodynamics, and measurement. Their scientists have supplied the basic building blocks of molecular structure and precise physical properties of the important fuel products and intermediates first isolated in contractor laboratories.

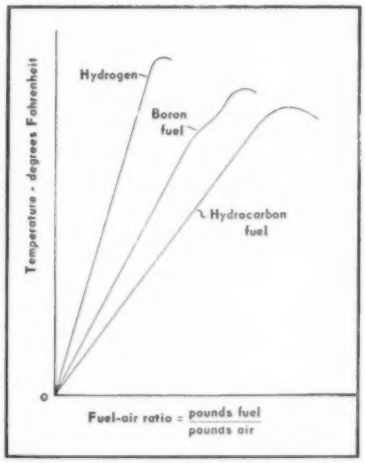

Fig. 1. Fuel burning characteristics.

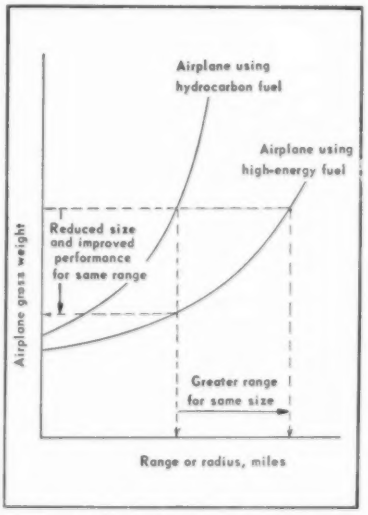
Airplane using hydrocarbon fuel
Airplane using high-energy fuel
Reduced size and improved performance for same range
Greater range for same size
Airplane gross weight
Range or radius, miles

Fig. 2. Advantage of high-energy fuel.

What about rockets? All the exotic fuels considered have possible application in rocket engines and offer considerable increase in specific impulse over a standard combination such as gasoline and liquid oxygen. Foreseeable aircraft uses of nuclear propulsion do not appear to be in competition with high-energy fuels.

The most promising high-energy fuels are moving out of the research phase into limited production. Costs are high—a pound of any of the boron fuels today costs over a thousand times more than a pound of jet fuel.

This situation is quite comparable to that of titanium some ten years ago. The increase in the use of titanium and the reduction of costs have gone hand in hand and it is currently used in many applications where its superior properties outweigh its higher cost.

Because of their high reactivity, practically all high-energy materials exist naturally only in a highly oxidized or combined form having a very low energy level. These starting materials must be upgraded to the desired high energy by the application of energy from an outside source such as heat or electrical power. This processing is costly, since it requires the input of five to ten times as much energy as is imparted to the final fuel product.

The fuel stores this energy in a highly compact and usable form. Used in bombers and attack aircraft, high-energy fuel can reduce or eliminate the need for refueling, depending on target distance. Fighter aircraft can fly higher and fight longer. Missiles can be smaller or have greater range.

BEFORE we can realize these goals, problems must be solved. For the boron-carbon-hydrogen fuels, the predominant problems are corrosion, erosion, and the deposition of exhaust products in the engine; developing non-reacting seals and elastomers; and the visibility of exhaust products. An important goal is to develop engines which can use boron fuels and hydrocarbon fuels interchangeably. For fuels—normally gases such as hydrogen and diborane—the problems of handling and storing refrigerated liquids at very low temperatures and packaging large volumes into strong and aërodynamically efficient airframes are the foremost problems to be solved.

The real future of high-energy fuels is being decided in the laboratories and testing activities of the aircraft industry and the Government. The supersonic era of military aviation has already begun. We must have aircraft and missiles that will fly higher, faster, and farther than those of a potential enemy.

For some missions, high-energy fuel can do the job better than our present fuels. For other missions, *only* high-energy fuels can meet our requirements. Engineering developments for military requirements will pave the way for commercial uses in the future. Costs will be reduced to feasible levels.

Military Miniaturization

The need for speed and accuracy in modern weapons systems has resulted in the development of small and efficient electronic components that are finding use in land, sea, and air ordnance

Walter A. Murphy

THE weapons system has developed from a simple cannon fired by human judgment and muscle to a near-human device that will seek a target, pick it up and track it, plot its location continuously, and then position and fire the gun for proper lead.

The gun is now only a part of a system that has blossomed into electronic, hydraulic, mechanical, and optical components. The need for longer range, accuracy, and automatic fire has added directors, computers, radar trackers, power drives, hundreds of electron tubes, and miles of interconnecting cable.

This complexity has created a problem for all branches of the service—how to make this fire-control equipment fit into the modern weapon without sacrificing mobility, speed, and maneuverability.

One of the key processes in meeting this demand is miniaturization. The Army's 75-mm. Skysweeper antiaircraft weapon represents a fine package of miniaturization, compactness, firepower, mobility, and ease of repair and maintenance.

THE Skysweeper fires forty-five rounds a minute, can track the rapidly maneuvering seagull, and will instantly respond to automatic or manual signals. Mounted on a bogey with a hydraulic lift, it carries a computer, radar-tracker, power cases, hydraulic pumps, gearings, and the gun itself—all in one mobile package. Small, removable chassis can be slipped in and out of its fire-control units like tiny drawers to permit the technician quickly to replace the whole chassis instead of searching for the electron tube that has failed.

Mr. Murphy is a technical publications expert with S. Gunnar Myrbeck & Company.

The army's new mortar spotter, AN/MPQ-4, has a built-in brain which helps to make it faster thinking, more compact and mobile than its predecessors of the Korean war. The radar senses enemy projectiles and presents them as blips on its screen.

When the operator centers hairlines on those blips, the computer then gives a direct reading of the enemy's source of fire. All but the spotter's power supply can be mounted on a two-wheel trailer. Miniaturization of components and packaging techniques have contributed to this weapon's mobility and compactness.

The airborne problem is even more intense. Nine electronic systems (including fire control) are needed in today's fighters as compared with three in World War II. A complete World War II bomber could be bought for the price of the electronic equipment on just three of today's bombers. Fire control and flight control have been integrated into a system that senses an invisible target, tracks it, guides the airplane to it, and fires the guns.

More and more equipment has been added to accomplish fire-control and flight-control automation. Yet the space for it has not increased. Even the whole airplane, in some cases, has been made smaller and faster to make radar detection by the enemy more difficult.

Components must withstand more severe environmental forces brought about by higher altitudes and supersonic speeds. Yet they must be made smaller, lighter, and be packaged and shaped to fit the curvature of the airplane's fuselage or nose section.

SOME amazing accomplishments stand out in this airborne dieting. Control amplifiers, heart of voltage regulation for an airborne fire-control system, have been reduced to a small package weighing eleven ounces. Capacitors are down to 0.145-inch thickness. One of today's complete fire-control systems weighs only 150 pounds, supported on mountings that weigh less than 5 pounds.

The Aëro 13, designed for the F4D Skyray interceptor, includes a radar, computer, and optical system in one cylindrically packaged unit small enough to be slid almost entirely into the nose of the plane.

Some squeezing and special design were necessary to fit the F-89C "Scorpion" with a new nose and gun. Cameras, gun, and electronic equipment in the nose were used to probe advanced ballistics. The gun, pointing downward, was fired cross-wind while the

airplane flew over the ballistics range at Eglin Air Force Base, Fla.

A single projectile, equipped with a self-destruction time fuze, was fired downward toward the range. The projectile exploded at a predetermined time after firing. Four ballistic cameras on the ground recorded the exact point of firing and the exact point of explosion. A survey camera in the aircraft recorded the direction of firing.

All this equipment—gun, cameras, radar, and other electronic equipment—was fitted into the nose of the aircraft. From the data received, final tables for cross-wind firing were made.

OTHER important savings in weight and space will be made by break-apart construction, plug-in units, and smaller packages flexibly adapted for space requirements. The new Lockheed F-104 Starfighter, designed for maneuverability at supersonic speeds, has separate units of its electronic system which can be plugged in place, or unplugged, to provide the craft with just the electronics necessary for a specific mission being flown.

Since the whole airplane is a weapon system, its maneuverability and speed are directly related to its attack potential. Each part's weight and size contribute to that potential. Attempts have been made to reduce all parts and assemblies. The new General Electric J-79 engine, for instance, possesses the highest ratio of thrust per pound of any engine in its power class.

The Navy is becoming strict in its requirements for manufacturers to meet weight and performance estimates of new aircraft. Profits were cut on a jet basic trainer because the aircraft was ten pounds overweight and its stall speed was six knots higher than predicted.

The importance of smaller packages can be realized by a glance at recent figures indicating that each ten pounds of aircraft and fuel components must carry one extra pound of electronic equipment. This equipment must function at high temperatures without a cooling system. If refrigeration is needed, the space problem again arises: where to put bulky refrigeration units?

The transistor is making military electronic equipment smaller, lighter, more reliable, and less power hungry. It is predicted that the transistor market will multiply almost five times in the next three years. Military needs will take 11 million in 1957, 42 per cent of the total of 27 million. The apparatus division of Texas Instruments, Inc., reports production of transistorized military equipment with size and weight reductions as high as a hundred to one.

And yet a new component, the cryotron, might someday replace expensive transistors in certain circuits. The cryotron is so small that a hundred will fit into an ordinary thimble. Developed at Massachusetts Institute of Technology, this tiny device consists essentially of a straight piece of wire with another wire, as fine as a human hair, wound around it as a control winding.

Two rare metals, tantalum and niobium, are used to make cryotrons. These metals are stronger than copper and become superconductive at liquid helium temperatures. Small, easily made, low-resistant cryotrons may help to shrink electronic equipment even more. Perhaps they, or transistors, may someday replace the more than 1,000 bulky tubes of a modern jet bomber—tubes that cost anywhere from 60 cents to $681 each.

Printed wiring has made outstanding contributions to airborne electronics. Not only has it increased the uniform quality of the circuit, but it has reduced the weight of the final equipment in which it may be used. Microwave antenna arrays, heretofore difficult and costly to manufacture, are cheaper and more simplified in design due to printed-wiring techniques.

The short life of the guided missile has given a push to miniaturization and more rugged accessories. Weight and space are at a premium, and the cry is for more compact, lightweight, reliable components. One might get some idea of the results of missile miniaturization when viewing the Nike guided missile. Though only 20 feet long, a foot in diameter, and weighing little more than half a ton, it contains 1,500,000 separate parts ranging from the warhead to minute electronic parts smaller than the human thumb.

A RELATIVELY new contribution to weight and size reduction in missiles may soon be made by more common use of infrared radiation techniques and applications. Compared with radar, infrared systems are relatively simple, lighter in weight, and low in cost. With smaller scanners than radar, they can sometimes achieve better results.

It is possible to build an airborne infrared system for guidance or interceptor fire control that weighs and costs only about one-tenth as much as a radar system. Better target definition may be obtained with a 4- to 6-inch infrared scanner than with a radar 24-inch dish.

Infrared circuitry is less complex than radar circuitry as a rule. The Sidewinder missile has an infrared guidance system with only seven tubes as against several dozens for the radar-guided Falcon. The Sidewinder missile is not only simple, small, and lightweight, but it has an unusually high single-shot effectiveness. It requires no complex launching equipment and can be carried by single-seat interceptor aircraft.

Size again plays an important, though problematic rôle in infrared development. Its detector, for instance, requires laboratory manufacturing techniques. One thin sheet of fragile oxide material, ten microns in thickness, is sliced into flakes as small as 0.1-mm. As though this weren't difficult enough, electrical wires must then be attached to it.

THERE are still problems with infrared, just as there were with radar. However, when its target discrimination and other problems have been solved, we could have a small, accurate, reliable missile immune to enemy jamming and interception.

In our attempt to make the supersonic airplane automatic in flight and fire control, we have just about reached the limit. The only thing left in the aircraft for reduction in size is the pilot. Ironically, we have made him larger with suits and helmets. Here we must substitute the synthetic for the natural.

Though nothing can take the place of man's reasoning powers, we must replace the pilot with a thinking robot adapted to the million dollars' worth of electronic devices and the supersonic speeds of the aircraft. In effect, we must make missiles with their own built-in fire control and flight control.

Amazing as it might seem today, tomorrow will find smaller missiles doing a variety of tasks for industry and the military.

Measurement Standards

The Navy Bureau of Ordnance has begun a program to ensure that the services available at the National Bureau of Standards are fully employed for each test performed in all phases of armament research

J. L. Hayes

Mr. Hayes is with the Production Quality Division of the U. S. Naval Ordnance Laboratory, Corona, Calif. This article is taken from a paper presented before a recent meeting of the A.O.A. Dimensional Standards and Metrology Division, Washington, D. C.

WITH the advent of increasingly complex and technically demanding ordnance material, today's testing and measuring equipment is being called upon to perform to degrees of precision and accuracy rarely encountered a decade ago. Measuring accuracies which were once considered possible only in laboratory environments are today commonplace in field installations.

Due to the increased complexity of metrology, controls and systems are critically needed to provide the continued high accuracy of test and measuring equipment and to ensure compatability of identical tests or measurements.

In the electronic-electrical measurement area, requirements for field accuracies of 0.1 per cent have replaced past accuracies of 5 to 10 per cent. Electronic microwave measurements require accuracies which closely approach accuracies attainable only in such laboratories as those of the National Bureau of Standards. These stringent accuracy requirements exists in all electronic measurement areas of voltage, current, power, frequency, phase, impedance, and attenuation from zero cycles a second to several thousand megacycles a second.

IN other phases of metrology, defined as the science of measurement, stringent accuracy requirements exist in many locations, especially in manufacturing plants, in the static and dynamic measurement of pressure, force, flow, acceleration, vibration, temperature, radiation, optics, mass, and chemical phenomena. Problems are particularly severe in the dimensional measurement of dynamic displacement associated with acceleration and vibration measurements.

Serious problems have arisen in field, depot, factory, development, and evaluation activities because of the inability of the measurements of one activity to agree with those of another activity even though identical items are being measured. There has been a strong tendency to write off this incompatibility of measurements as a variation of the item under test, whereas, in reality, a large portion of the incompatibility is due to the fact that the performed measurements were not standardized.

These incompatibilities have resulted in undue rework and return shipping of ordnance material as well as the development and production of items which had a high rejection rate because of incompatibility of factory test measurements and research and development activity measurements. Tactical malfunctions also are attributable to these causes. Such problems result in excessive ordnance costs and unreliability.

Obviously, all this points out the need for a measurement standardization system for each phase of metrology. The need for a system to standardize dimensional measurements was recognized and has been in existence for several years. The same type of system is required for other measurement areas of metrology such as electrical, electronic, and physical phenomena.

FOR many years the National Bureau of Standards has provided standards and standards services for the Nation. These services have been available to those who voluntarily sent their various standards to the Bureau for certification or calibration.

A few organizations have utilized these facilities fully, but, unfortunately, many activities and manufacturers have failed, for various reasons, to avail themselves of these services or have used the services with such infrequency as practically to negate the advantages gained through measurement standardization.

One of the most pronounced reasons for not using the services, other than a lethargic attitude, has been the failure to recognize the merits and the basic needs for them.

The Navy Bureau of Ordnance has

recognized the general lack of standardized measurements throughout the Nation and has initiated a program to ensure that the excellent standards and standards services available at the Bureau of Standards are fully employed in such a manner as to provide measurement standardization throughout all phases of ordnance for each performed measurement or test. This program of measurement standardization has been designated as the Bureau of Ordnance Calibration Program.

The over-all mission of the calibration program is to ensure the maintenance of accuracy within design limits of all testing and measuring systems employed in the test of ordnance materials and systems for the Bureau of Ordnance.

The task of studying, planning, and implementing the entire calibration program was assigned to the Naval Ordnance Laboratory, Corona, Calif., in February 1955. As a result of the study phase, it was determined that several conditions needed to be established to ensure the adequacy of a calibration program. These conditions include:

1. The determination of the field, depot, factory, and development activity measurement requirements.

2. The establishment of a suitable calibration structure which would allow for the referral of all measurements to a common source.

3. The designation of specific standards, associated equipment, and necessary related calibration procedures and techniques for each level of the calibration structure.

4. The designation of the frequency of calibration for each item at the various levels in the structure.

5. A system for the continued analysis and quality assurance of over-all calibration system operation.

THE program needed flexibility to provide for changing requirements and to keep pace with, evaluate, and provide for the development of standards in critical "state-of-the-art" limitation areas. The Naval Ordnance Laboratory, Corona, established an organization to provide the diversified technical and scientific talent necessary to such a varied program. Physicists, engineers, and statisticians were required to provide effort on electronic, electrical, mechanical, and physical measurement areas.

A calibration structure was established based on technical, administrative, and logistic considerations. At the apex of the structure is the National Bureau of Standards, ensuring the common reference for all measurements. Primary, secondary, and local standards laboratories of the Bureau of Ordnance are required to meet the work load and geographical complexities of the program. The function of each of the laboratories in these echelons is to provide standards services for those standards employed at each lower echelon.

STANDARDS laboratories were specified for the various echelons within the structure. The geographical locations of the three Bureau of Ordnance primary standards laboratories are:

1. The Western Primary Standards Laboratory, office of the Naval Inspector of Ordnance, Pomona, Calif.

2. The Midwestern Primary Standards Laboratory at the Naval Ordnance Plant, Forest Park, Ill.

3. The Eastern Primary Standards Laboratory at the Naval Gun Factory, Washington, D. C.

Each BuOrd primary standards laboratory services BuOrd secondary standards laboratories within specifically assigned geographical areas.

The secondary standards laboratories are located at BuOrd depots; quality-evaluation laboratories; development, test, and evaluation activities; and the plants of ordnance contractors where work load, logistics, and accuracy requirements dictate the need for secondary standards.

Local standards laboratories of the Bureau of Ordnance are located at activities in which secondary standards laboratories are situated and at those tactical units which employ ordnance testing equipment. Again, the establishment of the local standards laboratories is based on logistic, work load, and accuracy considerations.

Some activities may have several local standards laboratories which are serviced by the one secondary standards laboratory at the activity. Others may have only one or two local standards laboratories serviced by the secondary standards laboratory. Still others may have no secondary standards laboratory, since the services available at the local standards laboratory may be considered sufficient to meet the entire needs of the activity. Local standards laboratories at these activities would be serviced by specifically designated secondary standards laboratories at other activities.

Standards and all auxiliary equipment have been designated for both the BuOrd primary and secondary standards laboratories for the majority of measurement areas normally encountered in ordnance work. It has been necessary that these equipments be chosen with the utmost caution to ensure that reliable construction and permanency of values are obtained. This has required that equipment be designated under the strictest of specifications from manufacturers of high reputation and long experience in producing standards and auxiliary equipment of demonstrated excellence.

The need for permanency or stability is a most stringent requirement in that any undetected change in a standard may readily initiate a chain of expanding error throughout a plant or activity and cause losses of time and material far exceeding the original cost of the standards and standards services.

THE two general types of standards in the program have been given names depicting their function. These are reference standards and transfer standards. Reference standards are those which are employed within a given standards laboratory to maintain continuity of value in the units of measurement that they embody. They are used to calibrate lower echelon standards.

Transfer standards are similar in nature and inherent accuracy to reference standards but are shipped back and forth from lower to higher echelon laboratories. Their function is to transmit a unit of measurement from the higher echelon laboratory to the lower echelon laboratory. These transfer standards are normally of fixed value and ruggedly constructed to ensure retention of the original measurement unit under shipping conditions.

In the standardization of d.c. voltage, saturated cadmium standard cells are employed at the primary standards laboratories because of their high inherent stability. Unsaturated cadmium cells are employed at the secondary standards laboratories and, in conjunction with auxiliary equipment, are used to calibrate precision meters located at local standards laboratories.

In all measurement-standardization chains, the standards of the lower echelon laboratory are periodically submitted to the higher echelon laboratory for periodic calibration.

The standardization chain for "X" band (8.2 to 12.4 kilomegacycles) microwave attenuation employs a 30-megacycle attenuator as the standard at the primary standards laboratory in what is termed an intermediate frequency attenuation system. The 30-megacycle attenuator is a precisely machined cylinder with a very accurately positioned plunger whose location in the cylinder determines the amount of attenuation being applied to a microwave circuit.

At the secondary standards laboratory a special precision attenuator such as the PRD Model 150 is used to calibrate other precision attenuators, such as the PRD Model 195B, the H.P. Model X382A, and the Sperry Model 134, at local standards laboratories.

The primary standards laboratories use proving rings of varying ranges as the force standard. These in turn calibrate dynamometer rings of the secondary standards laboratory. Equipments such as SR-4 strain gages, testing machines, and hardness machines at the local standards laboratories are subsequently calibrated by the secondary force standard.

The standardization chain for mass measurements employs Class "M" and Class "S" nichrome stainless-steel weights at the primary standards laboratories, Class "S-1" weights at secondary standards laboratories, and Class "P," Class "Q," and commercial class weights at the local standards laboratories.

Providing the necessary standards for each measurement area and each echelon in the standardization structure was only one of a number of necessary facets to the calibration program.

CALIBRATION procedures are nearly as important to the program as the standards themselves. It is one thing to have the standards on hand at a laboratory and quite another thing to be able to utilize them correctly and consistently. All the pains of providing identical standards for each type of laboratory to ensure compatibility would be for naught if the procedures used did not ensure consistent techniques and minimize operator errors.

"Serious problems have arisen in field, depot, factory, development, and evaluation activities because of the inability of the measurements of one activity to agree with those of another activity even though identical items are measured."

Techniques and procedures presently in existence are being adapted to the needs of the program and presented in a standard format. These procedures are closely screened to ensure that they are sound and appropriate for the intended measurement, consistent from like type of measurement to measurement, adapted to the experience and ability of personnel, and stated concisely, clearly, and accurately. Each procedure is proofed in actual laboratory conditions prior to formal issuance.

Techniques and procedures for newly developed standards or altered calibration systems also are being devised. In certain cases it has been found that the choice of techniques to be employed is of more importance than the choice of standards or calibration equipment. Such is the case in the measurement of microwave attenuation. It frequently has been necessary to devise unique techniques to circumvent problems arising because of the absence of more accurate standards or associated equipment.

A measurement-standardization program without arrangements for periodic recalibration is akin to having no program at all. Unless standards and measuring instruments are calibrated frequently enough to ensure that they have not drifted beyond prescribed limits, they will produce erroneous data and will create a false impression that measurement standardization exists when in reality such is not the case.

This periodicity of calibration has been designated as a calibration period —the length of time between calibrations for a particular item. Calibration periods have been designated for all standards, associated equipment, and commercial measuring equipment encompassed by the program. Some of these periods were based on the experience and opinions expressed at existing standards laboratories across the Nation, while many periods were based on such factors as operating environment, history, type of equipment, caliber of user, and type of construction.

State-of-the-art limitations have necessitated a search for standards and equipment which can be adapted to the technical needs of the program as well as the development of new standards to meet specific measurement problems. The modification and adaptation of special standards to the needs of the primary and secondary standards laboratories are an example of the approach taken.

The National Bureau of Standards at Boulder, Colo., recently has developed an attenuator-thermocouple voltmeter. This device, when modified to meet the special problems of the primary and secondary standards laboratories, will provide an excellent transfer standard for vacuum-tube voltmeter calibrations and other high-frequency electronic equipment calibrations.

A TRAINING program has been set up to provide standards and measurement training to personnel of the several laboratories in techniques, procedures, laboratory operation, and overall calibration philosophies. Initially the training will be limited to personnel of the secondary standards laboratories at naval activities; later, the training will include those persons whose needs for training are less critical.

A quality-assurance program within the calibration program has been initiated to ensure the final operable adequacy of the program and to provide for periodic revision and special problem solution wherever necessary. Calibration data report forms are utilized by each standards laboratory to feed back information.

These in turn are reduced to punched cards and are automatically programmed for analysis to determine such factors as stability and adequacy of standards, effects of varying logistics and laboratory environments, and the adequacy of calibration periods and procedures. In addition, the system will provide for the feedback of operational suitability information to design, development, test, and evaluation groups on field, depot, and factory test equipment.

Another function of the quality-assurance program will be that of conducting laboratory quality tests. The tests will be accomplished for several

typical measurement areas by having a transfer standard certified by the National Bureau of Standards and then placed in a "black box" and sent to all BuOrd primary standards laboratories for subsequent measurement.

The value of the black box will be unknown upon receipt, and each laboratory will measure the value and record the findings on a calibration report form. These forms will then be compared with the certified value known only to quality assurance personnel.

Thus, an indication will be obtained as to the competence of the laboratory in performing measurements in the area covered by the black box. Such tests will be conducted throughout all standards laboratories to determine quality and to engender a competitive spirit between laboratories.

MONTHLY newsletters will be initiated to provide informal communication to each laboratory in the program on such matters as new developments and techniques, achievements of high-quality standards laboratories, suggestions from laboratories on improved procedures, modifications to equipment to achieve improved measurements, and so forth.

The Navy Bureau of Ordnance calibration program has been designed to ensure the continued accuracy within design specifications of measuring equipment, thus ensuring greater reliability throughout ordnance tests. It is strongly felt that the program will provide an increased interest throughout the Nation in better, more accurate measurements that are standardized in all reasonable respects.

Those activities and organziations which have ignored the needs for complete measurement standardization because of economic considerations will see concrete evidence of the technical advantages of such a program and the economic profits to be gained.

Firms supplying those contractors who are already integrated into the program will, of necessity and by choice, seek measurement standardization services for their own plants.

The effectiveness of a measurement-standardization program can be severely crippled by improperly selected test instrumentation. The considerations surrounding the proper selection of measuring equipment are themselves of sufficient stature to require a separate paper on their many aspects, and it is regretted that such detailed discussion is not within the purview of this analysis. However, a brief summarization of the technical details of proper instrument selection and operation is as follows:

1. It must be determined just what accuracy is required for an intended measurement. It is, of course, desirable that the old "rule of thumb" be applied and that measuring systems be ten times as accurate as the tolerances or test specifications of the systems being measured, whether this be in calibration or testing work.

For example, if it is desired that a test be performed on a capacitor which has a test tolerance of plus or minus twenty per cent, a measuring system should be selected which has an accuracy of plus or minus two per cent. Many state-of-the-art limitations frequently preclude the ability to maintain such a ten-to-one accuracy ratio.

It has been necessary that statistical studies be performed to find the lowest allowable accuracy ratio for the calibration program. These have shown that the lowest allowable limit for the majority of measurements is four to one. This ratio provides, for most measuring systems, measurements which are in error less than three per cent of the time. In contrast, a 10-to-1 ratio yields measurements which are in error only 0.8 per cent of the time.

2. Having determined the measurement accuracy required, it is necessary that a measurement system be selected which meets the requirements. You will notice that the accent is placed on "measurement system" accuracy rather than on "instrument" accuracy. Frequently, the error introduced by detectors, amplifiers, bridges, potentiometers, and other auxiliary equipment is overlooked in favor of the error of the standard or prime indicating instrument.

IN many cases the errors contributed by such auxiliary equipments far exceed those of the indicating instrument. For most normal applications the determination of total system error can be computed by combining all component errors of the system by the root-sum-of-squares method.

Final caution should be given to the manner in which the accuracy value of each instrument or item of equipment is applied. Every instrument manufacturer normally states the rated accuracy of his equipment; however, the "fine print" should be scrutinized before taking the accuracy rating at face value.

Accuracy ratings for instruments are usually given in percentages of full scale, not throughout the entire instrument range. The safest approach is to determine the quantitative error and apply it throughout a given range. If it does not exceed accuracy requirements at the point on the scale where the measurement is being read, then the instrument has been properly chosen.

THERE is an equal tendency to overlook the fixed-value error of some equipment. Accuracy ratings for these equipments are given as, say, plus or minus one per cent plus or minus one scale division. At measurements on the low end of the scale, the error contributed by the plus or minus one scale division far exceeds the one per cent accuracy figure. Again, the fine print needs to be read and thoroughly understood before employing any equipment for measurements.

3. Finally, measurement problems and errors arise because of other influencing factors which are frequently overlooked. These are: (a) Failure to account for errors introduced by dynamic rather than static conditions; (b) Failure to consider proper instrument placement where magnetic effects, lead lengths, etc., are critical; (c) Failure to consider deleterious environment effects; (d) Failure to consider loading effects of the instrument on the item or system under test; and (e) Failure to consider the human engineering aspects of instrumentation, such as the selection of equipment whose complexities exceed the skill of intended operators.

The measurement-standardization system as established by the Navy's Bureau of Ordnance is not intended to be a panacea for all measurement problems; rather, it is intended to be a means of pinpointing and containing those problems.

It is the sincere hope of all who are engaged in the program that this is truly a step forward in improved measurements for the armed services.

Modern Metal Containers

Lighter coated tinplate, improved steel physical characteristics, chemically treated black plate, and newer organic coatings may make possible the development of better and cheaper containers

A. L. Hartung

IT is the purpose of this paper to give a brief insight into some of the more commonly used materials in can manufacture, their means of subsequent fabrication, and the physical characteristics of the complete containers with respect to ordnance requirements.

Can makers and their suppliers have collaborated to meet the demands of the ever-changing world in the packaging industry. In the space of a few short years, technological developments have permitted us to introduce a good portion of yesterday's research into actual practice. This is further witnessed by the fact that reference is made in terms of "billions of units" when describing the yearly productivity of the can-making industry. We are doing this in direct competition with all types of containers used by the packaging industry.

IT is not our intention to rest upon our present laurels but to continue with more intensified research in the associated fields of science and engineering in order that today's research will contribute to greater efficiency in future operations. We are positive this research will produce mutual benefits to both the producers and consumers of the vast container industry.

With our eyes on the future, it may be well to pause for a moment and reflect whether or not some of this research can be directed toward the requirements of ordnance, keeping in mind the following possible advantages: (1) Mass production at a minimum of cost, (2) Manufacture with materials common to the industry in order that a ready inventory be available, and (3) Maximum savings of critical materials in time of emergency.

Mr. Hartung is with the National Can Corporation, Chicago, Ill. This article was originally presented as a paper at a recent meeting of the Container Committee of the A.O.A. Bomb & Artillery Ammunition Division held at Shreveport, La.

It is without doubt that a joint effort by ordnance and the industry could produce improvements toward the advantages just enumerated with many of the containers required by ordnance.

It is the industry's contention that we are not taking full advantage of the use of tinplate. Tinplate, with its variables of steel chemistry, temper, base weight, and tin coating, forms the largest part of the immense inventory that the can industry carries to meet the requirements of its customers. Economy and the requirements of the finished container govern the proper selection of these variables.

Hot-dipped tinplate described as "coke" plate with some variations of tin weight, has been used for canned foods for several generations. The emergency of World War II brought rapid development of .25- and .50-pound electrolytic plate with its proportional savings in tin. Almost two decades since its conception, the use of electrolytic tinplate has grown so that with the use of various enamels, and in some cases without benefit of a protective organic coating, it has become established as a standard container for many products. Depending upon the product, its use has concluded that downgraded metal has a corrosion shelf life equal to that of the hot-dipped plate formerly used and in many cases promotes a better quality packed product.

DIFFERENTLY coated electrolytic tinplate, carrying the equivalent of one pound of tin on one side and one-fourth pound of tin on the other side per base box, has become available commercially in the past few years. Research is developing its use as a substitute for plain hot-dipped tinplate with many products where enameled electrolytic plate cannot be substituted because plain tin surfaces are needed to preserve the quality of the product.

I have been amplifying the results of research with reference to interior corrosion of tinplate containers, but it must be noted that research also has been carried out with respect to the exterior corrosion of containers.

The Can Manufacturers' Institute, in collaboration with the United States armed forces and certain can manufacturers, made a 2-year study of the in-

fluence of tinplate, organic coatings, and other variables on the exterior rusting of cans. Its purpose was to provide evidence required by the armed forces so that optimum tin coatings on cans for military items could be specified and to permit maximum tin conservation in any future emergency.

Two years' outdoor exposure tests in areas typifying worldwide temperate, arctic, tropic, and desert climatic conditions as well as supplemented accelerated laboratory tests, provided some interesting results and conclusions.

A FEW of these that appeared of special interest were:

1. No perforations or other spoilage at any test site were traceable to exterior rusting on any of the test lots. This included plain exterior .50-pound electrolytic tinplate. Unfortuately, plain exterior 0.25-pound plate containers were not included in the tests since it had been anticipated that they would fail in a short time. Indications were that this might not have been the case.

2. Rusting decreased slightly with increased tin coating weights with uncoated containers, but organic coatings exhibited a much greater protective effect than did the heaviest tin coating weights.

3. Precoated (application of the organic coating on the flat sheet and then fabricating the containers) 0.25-pound electrolytic tinplate cans were more rust resistant than the plain hot-dipped tinplate cans used during World War II.

4. With precoated cans, scratches in the organic coatings did not appreciably reduce protection against rusting.

5. Side seams did not appear greatly rusted, indicating that side seams do not contribute excessively to can failure by rusting, and the requirement of side seam striping was judged not essential.

"Differentially coated electrolytic tinplate, carrying the equivalent of one pound of tin on one side and one-fourth pound of tin on the other side per base box, has become available commercially in the past few years. Research is developing its use as a substitute for plain hot-dipped tinplate with many products where enameled electrolytic plate cannot be substituted."

These results indicate that it would be logical to expect that a suitable container could be made of standard can-making materials with regular production equipment and still be satisfactory for the corrosion specifications of the armed forces.

High-speed production in can making has been geared to certain materials and methods established as being efficient for the facilities. Further investigation appears warranted in the following categories:

1. *Organic Coatings.*—Common practice with few exceptions is to apply the protective coating to flat sheets by means of roller coaters and bake in continuous ovens. The resulting plate is then made into cans. This method has proved successful for supplying suitable protection for both the interior and exterior of containers for the majority of our civilian customers. Tests performed for the military, as previously outlined, give good indications of successful results with this method of coating application. Economies are apparent by the use of organic coatings over thin coated electrolytic tinplate.

2. *Can Sealing Compounds.*—In view of our experiences with domestic cans from the standpoint of sealing efficiency, the matter of proper selection of can sealing compounds should be left to the manufacturer or supplier. The specifications, regardless, should be realistic and revised to meet the general requirements of lining practices on available equipment whether it be round or oblong containers.

3. *Solder.*—Solders having a tin content range of two to four per cent have proved satisfactory for food containers over the past fifteen years. It is admitted, nevertheless, that side seams do not have quite the bright appearance as do high-tin solders; however, it is more suitable for can construction because of the increase in side-seam strength. With the exception of soldering special containers or the attaching of container parts, industry has geared its production facilities employing low-tin solder. In many cases it has good manufacturing possibilities, and, therefore, it is logical that the military should scrutinize some of its advantages.

4. *Container Design.*—Containers must be designed to use the lightest weight tinplate that is practical, but they must withstand high internal vacuum or high internal pressure, whichever the case may be. The thickness, temper, and strength of the steel are important to the ability of the container to withstand these pressures. However, we must not overlook the benefits of structural design. Technological developments such as the design of the profile of the ends, rolled beads around the circumference of the body, or structural characteristics of the side seam have permitted the industry many economies in plate cost without sacrifice of the service of the containers.

"Almost two decades since its conception, the use of electrolytic tinplate has grown so that with the use of various enamels, and in some cases without benefit of a protective organic coating, it has become established as a standard container for many products."

WE are aware, nevertheless, that handling is a major factor with packaged military items; yet, in many instances it is possible to reduce base weights without sacrificing strength. Much depends on the diameter of the specific container, the physical characteristics of the metal employed, as well as structural design.

The influence of the physical properties by continuous annealing has not only added strength to the can bodies but also permitted the use of optional grain direction which again reflects some economy. A more recent development is the use of chemically treated black plate (Hynac and B-107).

All these newer innovations, such as lighter coated tinplate, improved base steel physical characteristics, chemically treated black plate, and better organic coatings, show the strides that have been made with metal containers.

It is the purpose of the can manufacturer and his supplier to continue to develop newer, better, and cheaper containers. Many unpredictable factors, such as higher prices for raw materials as well as increased labor costs, may offset potential savings; however, with the combined effort of all interested parties, a satisfactory container can be made at a minimum of cost.

Logistics of Missilery

The early adoption of an integrated "system approach" to the development of all logistic and operational factors is needed if effective progress is to be made in the guided-missile field

Lieut. Col. A. J. D'Arezzo and Lieut. Col. J. P. D'Arezzo

IN the field of guided missiles, the necessity for generally accelerated programs for matériel research, development, test, procurement, and for troop deployment, coupled with a rapidly advancing missile, electronic, and nuclear technology, has created a condition of fluidity and competitive endeavor which is unprecedented in military planning.

It is a field wherein large sums of money must be expended and a substantial military-industrial effort made, not only to provide basic, trail-blazing technical capabilities, but to translate these technical capabilities into significantly new and improved operational performance and effectiveness. This situation is likely to continue for years.

The Army effort expended in the last ten years, and still continuing, to reach the optimum in land-based guided missiles for air defense, epitomizes all the foregoing general conditions of urgency, new technical break-through, and fluidity of operational concept which characterize the whole guided-missile field. Since effort in this particular subdivision of missile weapon systems can be expected to continue until the air threat can be contained, it is worth while to analyze thoroughly our past experience and to scan the future.

AS a preliminary step in the discussion of the logistics of land-based surface-to-air missiles, it is essential to define two basic terms: "Operational Missile System" and "Logistics."

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An operational missile system for land-based air defense as used herein includes: (1) The missile; (2) Ground guidance equipment and associated facilities; (3) Missile-launching, handling, and servicing equipment; (4) Maintenance and operational test equipment; (5) Trained operational and maintenance personnel; (6) Field-maintenance shops and support installations; (7) Troop support and administrative facilities; (8) Equipment spares and reserves; and (9) Technical manuals.

Logistics, in its broadest sense, is defined for purposes of joint logistic planning as that part of a military activity which deals with: (1) Design and development, acquisition and storage, movement, distribution, maintenance, evacuation, and disposition of *matériel;* (2) Induction, classification, training, assignment, separation, movement, evacuation, and welfare of *personnel;* (3) Acquisition or construction, maintenance, operation, and disposition of *facilities;* and (4) Acquisition or furnishing of *services.*

The total encompassment of the elements of an operational missile system within the purview of logistics is apparent. Furthermore, the connotation that all elements of the missile system and the logistics system must be developed integrally and concurrently appears to be almost a foregone conclusion.

IT is noteworthy to emphasize, relative to the above all-inclusive definitions, that matériel design and development—which is the first step within the broad view of logistics—is but one part of the over-all logistics requirements for missiles. However, it is a most important part, and design decisions made in the development phase have as great an impact on subsequent logistic steps as they do on the basic theoretical effectiveness of the weapon itself. Thus, the elements dealing with the development of basic technical missile concepts are but components of the whole missile system and of the inclusive logistics system.

The concurrent and integrated development of all components is to be achieved either through the alchemy of continuous, extensive coördination and monitoring involving numerous interested agencies and staff divisions or, as adopted in certain services, by the adoption of a centralized project concept where total logistic coördination is achieved within a limited body and re-

tained therein throughout the development and service life of the weapon system.

Thus the first significant conclusion apparent from the past is a tendency contrary to the integrated and concurrent development of the various elements comprising the logistic or missile system. In the initial critical phase of weapon system development, it has evolved that the basic design and configuration of the missile and ground guidance subsystems are largely independent activities governed primarily by the performance and effectiveness objectives to be achieved by the weapon system in its primary rôle of air defense.

The remaining logistic elements of an operational missile system are, by and large, subsequently developed and adapted to the missile and ground guidance equipment after advanced stage of development or even procurement. These logistic elements, in turn, can be influenced to a marked degree by the special tactical or strategic considerations.

The impact of all logistic factors is worthy of the utmost consideration at a very early stage of development if a practicable, operational missile system of reasonable cost is to be achieved within the realistic limitations dictated by present and expected program budget ceilings, program priorities, and industrial capabilities.

NUMEROUS complexities and technical unknowns must be resolved in order to establish the basic workability of the missile system. Rapid advances and changes in missile technology have virtually obliterated the fine distinction between research, development, and procurement. In view of the above conditions of fluidity, it is understandable that there may be a natural tendency in the missile system design and development phase to postpone or even exclude consideration of the unique requirements of the over-all logistics system, which at best may be only in the formative stage.

Unfortunately, when the unique requirements of the associated logistic support system are formulated, limitations clearly established, and the full impact of these factors is realized, the system design has advanced to such a point that to introduce changes would slip "critical program schedules."

On the other hand, to ignore the pressure of logistics requirements creates the risk of excessive costs in money and manpower which might well cause the forced obsolescence, the limited use, or even the abandonment of the missile system even though successfully "developed" in the strict sense.

UNDER the foregoing circumstances three alternative courses of action are available:

1. Defer indefinitely, or disallow entirely, all equipment modifications and improvements, with the understanding that possible system degradation or underdevelopment is accepted as a calculated risk or that deficiencies can be absorbed by the logistic support system;

2. Adopt expedient, "last-minute" modifications which are deemed necessary at least to improve or alleviate the logistics aspects of the program, resulting in a missile system which, while providing great tactical advantage, is costlier from an over-all service program point of view than anticipated;

3. Expand the present "system approach" which is so indispensable in the development, testing, and preproduction phases of the weapon system itself in providing continuous technical integration and balance between the various technical components of the weapon system so as to include also the logistics system environment within which the operational missile system is to exist.

The first two courses of action essentially involve compromise, interim measures, and appear to be logical outgrowths of a reasoning which holds that the growth of a missile system to its ultimate level of effectiveness must be gained by gradual, on-site operational experience. The third course of action, providing for an integrated system approach, undertaken early in the missile system development phase, appears to afford the most likely solution to this fundamental problem.

This approach not only will exert a major influence in shaping the weapon system design, but also will reveal and allow for timely changes in logistic system and tactical concepts. An essential element of such an integrated-system approach would be a close and continuing scrutiny of tactical and strategical requirements.

"The elements dealing with the development of basic technical missile concepts are but components of the whole missile system and of the inclusive logistics system."

The desirability of adopting an overall system approach in the future is evident from the following discussion of logistic factors resulting from experience gained to date in antiaircraft defense programs. The force of logistic factors which to date have beset the task of establishing a missile system on a broad operational basis, throughout continental United States and overseas areas, involving varied terrain, climatic, and tactical conditions, bears careful attention of the military planner.

Under the cumulative impact of expedited operational requirements, frequent changes in technical and tactical concepts, and major reorientations in program objectives, logistics planning may be placed "on the defensive," so to speak, from the very outset of the program. Possessing, at best, only indeterminate or inadequate lead-time planning data to correlate and accomplish the various key logistic elements of a new weapons system, a substantial effort may have to be devoted in resolving "slippages and shortfalls" and in devising interim remedial measures therefor.

THE pressure of expediency and urgency is reflected in the following: (1) Utilization to the maximum of the existing logistic support structure rather than the establishment of a system specifically developed for the unique requirements of long-term usage and future growth of extensive antiaircraft objectives; (2) Frequent curtailment in period of advertising and construction of facilities projects; (3) Adoption of beneficial occupancy in so far as tactical facilities are concerned, to a degree heretofore not required in military construction. In some instances troops may have to be deployed at so-called temporary sites even before any portion of basic permanent facilities are ready for occupancy.

The logistic pressure can be further appreciated when it is considered that while a certain fluidity and change is to be expected within any specific fiscal year execution program, radical major changes are impractical since the long

lead times involved in programming and budgeting processes are premised on relative stabilization of programs at least two years in advance.

In addition, construction program authorizations are based on normal rates of accomplishment, and statutory limitations preclude expenditure of extra funds for expedited design, construction, and procurement.

From a concept of open-air, field-artillery-type missile sites initially adopted in 1952, antiaircraft defense facility requirements during the past five years have gradually evolved into increasingly extensive, complex, fixed, permanent-type installations. In effect, just as the "Indian threat" historically resulted in establishment of "fixed" outposts, and in a later era the "sea threat" necessitated fixed, permanent coast-artillery defenses, so today the "air threat" which is anticipated to exist for an indeterminately long period has unmistakably led to the inception of fixed, permanent, antiaircraft missile installations.

THIS trend in permanency and increasing self-sufficiency of antiaircraft tactical facilities is representative of the entire CONUS air defense programs. Our radar networks, extending in several lines across the North American continent and to the seaward flanks will further be developed and improved. Contiguous coverage off our shores will be steadily expanded as "Texas towers" are completed and picket ships and airborne early-warning radar are placed in operation.

The first segments of the Sage system, which will greatly speed up and improve the collection, analysis, presentation, and transmission of data needed for effective defense against air attack, will soon go into operation. The adoption of the Missile Master fire-direction system will coördinate the present Nike defenses. These elements of air defense, in every sense, involve fixed, extensive, and complex facilities.

The extensive construction which has been required to adapt to fixed-installation use the missile systems originally designed for mobile, field-army use, has entailed substantial engineering trial and error, and some of the early sites constructed incorporate variations in type and quality of construction. A continuous flow of facility changes to improve the operational, safety, and troop welfare aspects of installations has been required, essentially converting all facilities into permanent operational facilities.

"Numerous complexities and technical unknowns must be resolved in order to establish the basic workability of the missile system. Rapid advances and changes in missile technology have virtually obliterated the fine distinction between research, development, and procurement."

The current trend is to incorporate greater mechanization in existing facilities, with a view to reducing manpower requirements, and to increase operational efficiency. This piecemeal growth of installations is the outcome of the realization that long-term static antiaircraft defense requirements involve unique and distinctive support as compared with combat-support type or divisional units.

The introduction of the Missile Master, improvements to the basic missile system, and the increasing demand for automation will result in continued, extensive construction activity for many months.

The development of fixed tactical facilities involves detailed consideration and correlation of several major factors to ensure the full operational effectiveness and the safe employment of adopted missile systems.

A firm concept based on a thorough over-all missile-logistics system analysis must be formulated for the optimum operational and functional grouping of equipment to constitute a basic tactical unit; *i.e.*, number of launchers, etc. This entails development of tables of organization and equipment, the composition of the unit basic missile load, missile reserves, and training or nontactical loads. The development of defense areas must prescribe and designate the number and type of missile units required.

DEVELOPMENT of tactical facility designs and acquisition of land must be accomplished based on pretested technical criteria pertaining to electronic equipment, explosives quantity-safety distances, communications requirements, maximum utilization of existing government facilities, and the colocation of compatible facilities. Standard designs must be modified to cope with a wide variety of special terrain, climatic, and tactical factors.

Facilities must be designed and sited to permit the future rapid utilization and conversion to new weapon systems with a minimum of modification and without entailing wholesale abandonment of costly facilities. Closely regulated electric power generation equipment must be installed to meet the exacting power requirements demanded by the precision electronic devices used in guided missiles.

Design and construction of ancillary installations and facilities, including Engineer, Signal, and Ordnance maintenance shops, troop housing, administrative headquarters installations, fire-direction and control facilities, dependent housing, troop morale and welfare facilities, cannot be overlooked.

Finally, to preclude serious imbalances, firm schedules based on realistic lead times must be developed for site selection and acquisition and the design and construction of facilities, and these schedules must be reconciled and phased with equipment production and delivery schedules, availability of trained personnel and tested equipment packages, conversion of existing conventional gun troop units, and the activation of new troop units.

MISSILE launching, handling, checkout, and servicing equipment is usually referred to as missile ground support equipment. While this type equipment lacks the technical glamour currently connected with the missile and the associated guidance system, the impact of the design of this equipment upon the design and cost of the installation facilities should not be underestimated. The launcher, launcher installation, ready-missile storage shelter, missile transporter, missile handling gear, missile fueling equipment, and missile checkout sets are all closely interrelated, and, collectively or individually, these components along with tactical requirements dictate the site layout and organization, real estate, and manpower.

In fact, consideration of ground-support equipment and associated installations early in the development of the weapon system in close coördination with tactical objectives is sure to reveal necessary or desirable missile and guid-

ance changes, which, while not altering significantly basic weapon performance objectives, will serve to reduce costs and alleviate logistic problem areas. Such opportunities must not be left unexplored.

It is likely that many elements of ground-support equipment can be standardized among a number of air-defense missile systems. The potential cost saving inherent in this proposition justifies detailed investigation.

The relatively high and increasing production costs of missiles, the threat of forced obsolescence, and limitations of industrial production capacity unavoidably impose definite ceilings on the magnitude of missile inventories. The expectation of unlimited stockpiling in peacetime, or of unlimited production in wartime, cannot be realistically entertained in logistic planning affecting missile inventories, positioning, and resupply.

The manufacture of any particular missile system usually involves the combined, coördinated efforts of numerous component contractors and suppliers. It is evident that an enormous industrial base in special technical personnel and unique industrial plant would be required to meet the cumulative, unlimited demands of the various military services for a multiplicity of complex missile systems.

In addition, the constant prospect of forced obsolescence under an advancing missile technology dissuades any extreme attempt to exclude competitive systems or to place all available allocated funds and resources to the maximum production of a few selected systems.

THE virtual limitation on production quantities imposed by the above factors in turn vitally affects the rate of production learning curves and therefore the cost of missiles.

Thus, the continued expectancy of a relatively limited availability of missile and component system stocks in the future constitutes a logistic limitation of paramount importance which virtually dictates that stringent and drastic measures be adopted to reduce and eventually eliminate the sizable volume of missile and component inventories in supply pipelines and to reduce pipeline times by maximum use of air transport. Reduction of the supply pipeline is essential if maximum effective allocation of limited inventories is to be made for tactical, resupply, reserve, maintenance, and training purposes.

Current evaluation of Project Mass (design of a Modern Army Supply System) now under test indicates the positive necessity of attaining a solution to the logistic support of our modern Army overseas with its new and complex weapons.

THE importance of reducing pipeline inventories of prepared missile stocks is underscored if we consider the high probability of such stocks being regarded as primary targets in the event of hostilities and the problematical effectiveness of surface transport to resupply tactical facilities after basic missile loads have been expended. Thus, the present practice of assigning to fixed tactical facilities a certain basic load of ready missiles with subsequent resupply from zonal supply depots is at best an interim method which is likely to sustain serious alteration.

Inherent passive defense benefits resulting from the dispersed positioning of missile stocks at numerous tactical sites warrants serious consideration. The provision of adequate missile-storage and handling facilities at all tactical sites would reduce dependence on a few concentrated storage points for resupply backup.

Special packaging, handling, shipping, and in-transit storage costs for missile and missile components can approach a substantial percentage of the total equipment cost.

The desired objective discussed in the preceding section to reduce pipeline missile inventories and to utilize air transport would alleviate in large measure the high costs for special packaging, handling, shipping, and in-transit storage. In furtherance of achieving additional economies, serious consideration should be given to development of lightweight plastic containers.

In the future when optimum missile systems are standardized, it may be expected that complete, ready missiles or major integral components thereof may be factory-assembled and distributed in much the same manner as fixed rounds of conventional ammunition. Until the state of missile technology has reached that point, however, missile maintenance will require detailed component testing, replacement or repairs, carefully subdivided between organizational, field, and depot levels of maintenance.

One of the most crucial factors in logistics is the recruitment, training, and retention of military maintenance specialist personnel at all levels of the maintenance flow system. Present logistic support systems utilize contractor personnel to a varying extent. Excessive dependence on contractor personnel for maintenance may result in critical disruptions in the event of hostilities.

Under the impact of expedited schedules and the multiplicity of competitive systems, the theory of package treatment for "production, installation testing and maintenance by contractors," as proposed by various services, has the allure of a simple, direct course of action. However, the "package" theory, if applied indiscriminately, may involve such a disproportionate ratio of contractor to military personnel in the maintenance and resupply pipeline as to be extremely vulnerable to disruption in the event of critical manpower reallocation or in case of hostilities.

THUS, the establishment of a realistic missile maintenance support system will demand: consideration of the long lead times required to recruit and train specialists, the reconciliation of conflicting or overlapping requirements of diverse or competitive systems, and the establishment of optimum contractor-military personnel strength ratios; preparation of training facilities, equipment, and literature.

The widespread growth of unique or standard equipment furnished by other technical services such as the Corps of Engineers and the Signal Corps, involving hydraulic elevators, generators, frequency converters, compressors, intrabattery fixed plant cable and radio communications, and fire-direction systems necessitates the inauguration of maintenance and training programs of unprecedented magnitude.

The adoption of a comprehensive and integrated "system approach" to the development of all logistic factors and operational concepts from the very inception of a new weapon system concept, is essential if effective and meaningful progress is to be made under the increasingly competitive conditions which will obtain in the missile field.

Ordnance Electronic Brain

The Bizmac keeps inventory and forecasts supply requirements

Maj. Gen. Nelson M. Lynde, Jr.

WHEN a young Army officer from Washington arrived in Detroit recently, he hailed a taxi and said to the driver, "I want to go to the Ordnance Tank-Automotive Command headquarters. Do you know where that is?"

"Sure," replied the driver, "that's where the world's biggest 'brain' does its thinking."

Actually, the Ordnance Tank-Automotive Command (OTAC) headquarters is a good deal more than just the home of the world's largest electronic "brain," known as Bizmac. Still the cab-driver's statement is understandable. Since Bizmac's unveiling earlier this year, amid newspaper headlines and radio-TV publicity, it has become a local curiosity in the same class as the General Motors Building, Ford's River Rouge plant, and Briggs Stadium. So far, it has more than lived up to its press notices and is contributing importantly to the operation of OTAC.

That operation involves the development, design, manufacture, storage, supply, and maintenance of tank and automotive spare parts—everything from coils to carburetors, from washers to wheels.

General Lynde is commanding general of the Army Ordnance Tank-Automotive Command, Detroit, Mich.

A few figures will point up the scope of this mission. A typical transport vehicle requires approximately 4,000 separate maintenance items; a typical tank requires closer to 6,000. OTAC's total inventory includes more than 170,000 separate items. It furnishes spare parts for 145 different basic vehicles and over 1,200 different models.

Altogether, OTAC supports about 1,000,000 pieces of tank and automotive equipment.

The spare parts are stored at twelve Ordnance depots in the United States and overseas. Each depot serves the Army installations in its immediate vicinity. These depots report their supply transactions regularly to OTAC's Detroit headquarters. OTAC's job, in

the words of the famed Boston merchant, Edward A. Filene, is "how to have the right goods, in quantities neither too great nor too small, at the times when they will be desired most."

Surpluses could cost the taxpayers huge sums in warehouse expenses, carrying charges, and loss through obsolesence. Shortages could prove disastrous in time of emergency.

The Bizmac electronic data processing system, developed by the Radio Corporation of America, helps us to do our job more efficiently by performing three major tasks. First, it keeps inventory of spare parts. Secondly, it catalogs spare parts. Thirdly, it forecasts supply requirements.

As for inventory, Bizmac can handle in forty-eight hours a complex procedure that formerly required three months. It can tell instantly what supplies are on hand at each of our depots, how much is needed, what has been ordered and in what quantity, and how much material is in transit. By its more timely processing of records, Bizmac will make possible a sharp reduction in the amount of inventory we have to carry.

WE estimate that, over the next two years, our supplies can be trimmed substantially. This would mean that the cost of maintaining the inventory would be reduced by many millions of dollars. This, of course, would be a continuing saving. At this rate the Bizmac system would pay for its initial cost of $4.1 million many times over every single year it is in operation.

With regard to cataloging, Bizmac makes it possible to publish up-to-date manuals on spare parts within a few days after changes are made instead of having a lag of several months as was once the case. We can get spare-parts catalogs to the various depots even before a new vehicle is shipped. The Bizmac system ultimately will reduce by about 85 per cent our visible records which are now on some 10 million file cards, punched cards, metal plates, and handwritten sheets.

In forecasting, the Bizmac system is now predicting how many and what kind of parts each depot will need in the months ahead. Eventually, it will predict how many parts must be on hand or on order throughout the entire depot system to keep supplies flowing evenly from production lines to users. On the basis of these forecasts, slow-moving items can be kept out of the pipelines. From time to time Bizmac will forecast the spare-parts needs for advance budget planning and prepare comprehensive financial analyses.

"Bizmac contributes to efficiency in many ways. It can save time because it handles in minutes complex operations requiring months of paper work. It can help prevent shortages and surpluses because it enables us to forecast our requirements with greater accuracy and distribute stock more evenly . . ."

So much for what Bizmac can do. Now how does it operate? It operates through four basic units. There are input devices for preparing and feeding information and instructions into the system by means of coded electrical impulses. There are storage devices for filing this information on magnetic tape within the system so that it is readily accessible on demand.

There are data-processing devices for doing the electronic equivalent of "paper shuffling" and for making lightning-fast computations. Finally, there are output devices for providing finished copies of the information required. (An electromagnetic printer can produce shipping orders and other business documents at a speed of 600 lines a minute).

THE Bizmac system includes 220 units of 19 different but fully integrated types of equipment. It covers about 20,000 square feet of floor space, almost half the size of a football field. It can perform several operations simultaneously—file-searching, sorting, computing, printing—and control all of them remotely from a room known as system central which operates like a telephone exchange.

If one particular fact is needed quickly, an interrogation unit, situated in system central, can sift the system's 100 million facts and come up with the answer within 3 minutes.

It takes a lot of "brawn" to operate an electronic "brain." In the case of Bizmac, most of this "brawn" is supplied by women. More than 80 of the approximately 100 Army civilian employees working with the system are women who swapped their typewriters for tapewriters and other complicated pieces of electronic wizardry.

These workers were selected from within the Tank-Automotive Command on the basis of aptitude and experience and were given special on-the-job training in the operation of Bizmac components.

TRAINING of programmers, schedulers, analysts, and other key people to do the "thinking" for the system posed a special problem. We had to make electronics students from supply specialists and supply experts from electronics technicians. Now that we have a nucleus of trained operators and technicians, we are training additional workers to meet the demands of Bizmac's increasing work load. Much of the technical training is done through a one-year Government-sponsored program organized with the coöperation of Wayne University, Detroit.

From what we have seen of the Bizmac system in operation to date, we feel that it can contribute significantly to our job in two ways. First, it can streamline our operations and help the system to be more responsive to the Army's demands. Secondly, it can save the taxpayers substantial sums of money.

Bizmac contributes to efficiency in many ways. It can save time because it handles in minutes complex operations formerly requiring months of paper work. It can help prevent shortages and surpluses because it enables us to forecast our requirements with greater accuracy and distribute stock more evenly throughout our worldwide depot system.

Eventually, Bizmac can free a large number of employees for other jobs within the Tank-Automotive Command and other installations where they are badly needed because it will take over a host of routine clerical functions.

By promoting greater efficiency, Bizmac should bring about substantial economies in our operations. On all counts, we believe that Bizmac, over the years, will prove to be a wise investment—one that will help the Ordnance Corps to enhance the combat readiness of our Army and the Nation.

A Real And Present Danger

THE OLD WOODCUT above illustrates an all-glass electric generator. Over this we have superimposed a warning taken from a sign that is actually fastened to a door in one of our plants in Maryland. In the equipment and the sign we found a moment of amusement to share with you. But with the humor there is a sobering thought: In every field of human knowledge a real danger lies in resistance to bold, new ideas. In our own field of advanced electronics we have never resisted the unusual and we never will. Rather do we resist the usual, as we seek unique answers to the future.

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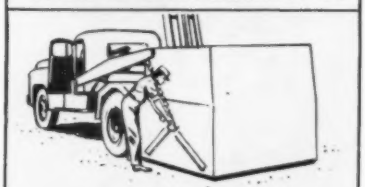

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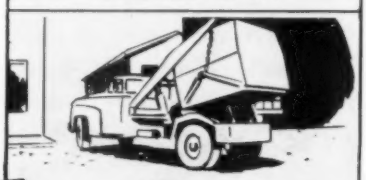

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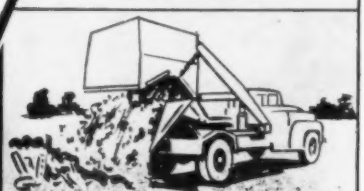

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Eimco selected a TORQMATIC Converter because the engineering facts—backed by years of experience in the most demanding applications—prove beyond question the greater efficiency and versatility inherent to the TORQMATIC design. Bring a new high in performance and efficiency to your equipment, with such cost-saving features as integral engine mounting which eliminates troublesome universal adapters—cast converter elements for longer service life and full-range horsepower—available only with TORQMATIC. Take a tip from Eimco and more than 80 other manufacturers of 122 types of road-building and construction equipment. Get the TORQMATIC story.

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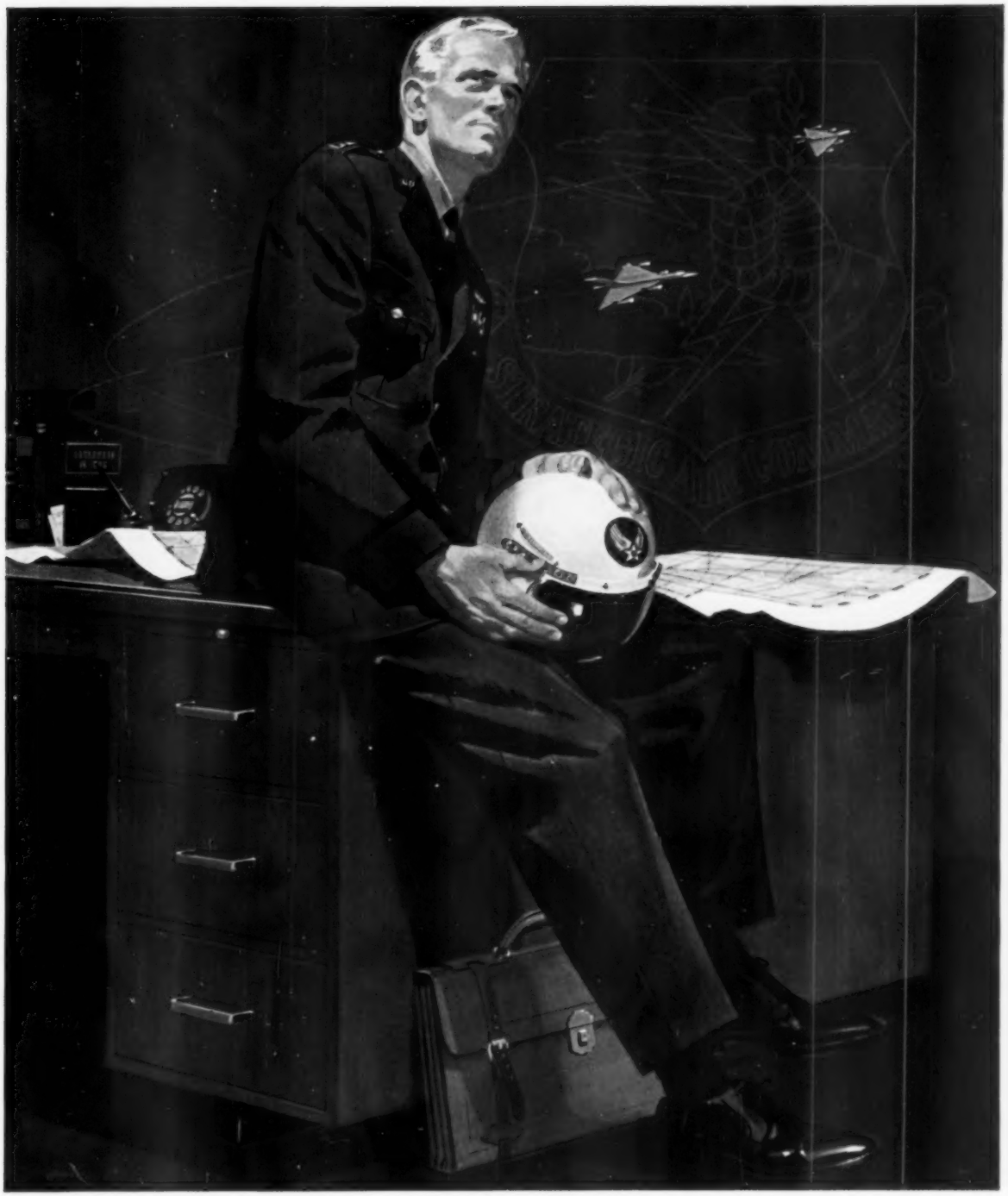

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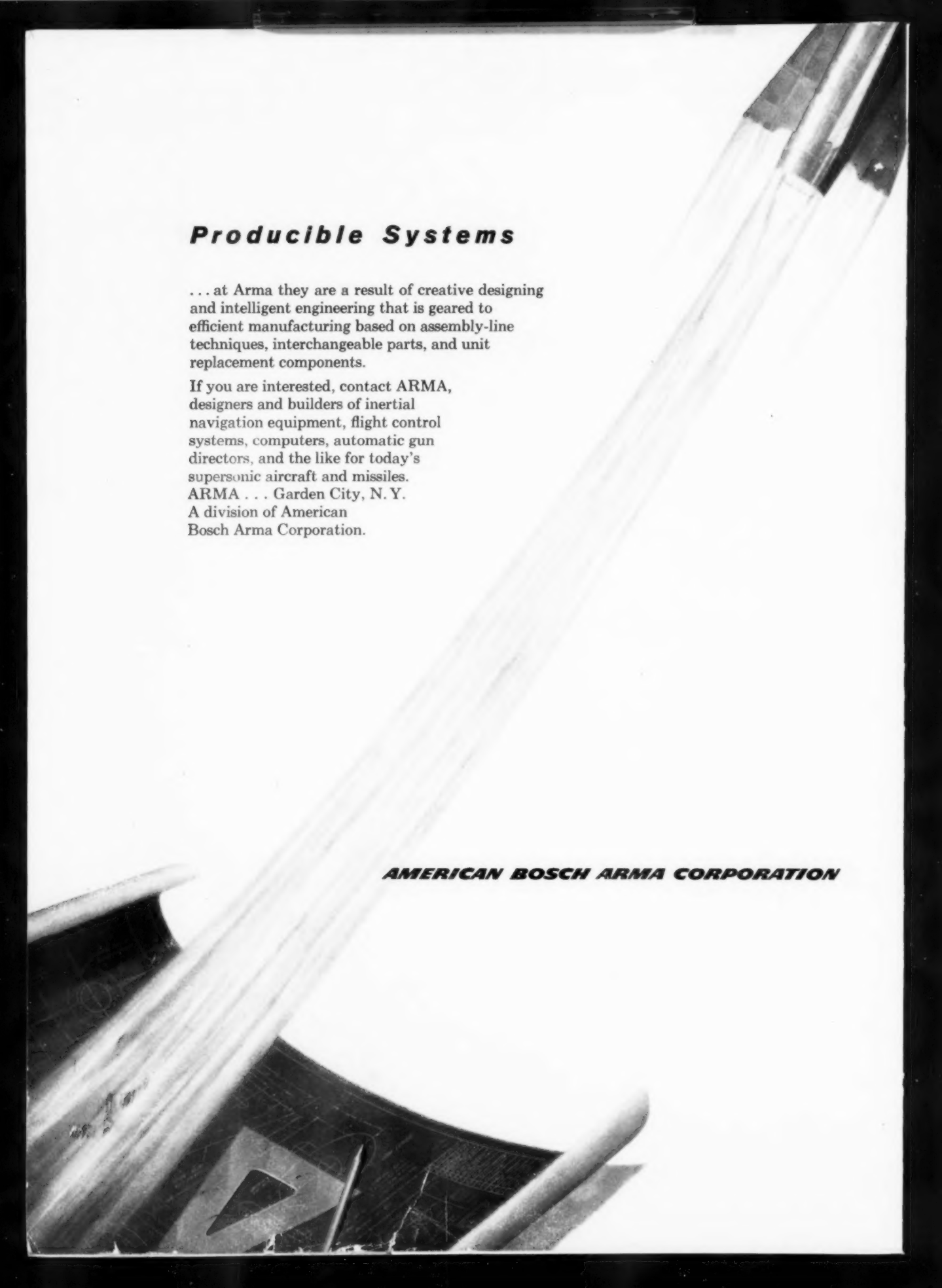

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